

RESTRICTED

# PESTICIDES ABSTRACTS

COMMONWEALTH INST.  
ENTOMOLOGY LIBRARY

- 8 SEP 1955

ERIAL *Official.*  
PARATE *B.13246*

&

EXD.

## NEWS SUMMARY

SECTION A

VOL I NO I

FEBRUARY 1955



## INSECTICIDES

COLONIAL INSECTICIDES FUNGICIDES & HERBICIDES COMMITTEE

COLONIAL OFFICE LONDON

The abstracts contained in P.A.N.S. are in general abstracts of interim reports. The conclusions stated are, therefore, tentative and may be modified by the results of subsequent investigations.

Permission to quote from these abstracts or the original papers must be obtained from the authors.

Enquiries should be addressed to: Colonial Pesticides Information Service, Imperial Institute, South Kensington, London, S.W.7.

## NEWS ITEMS

### (i) EAST AFRICAN AGRICULTURAL SPECIALIST ENTOMOLOGICAL AND INSECTICIDE COMMITTEE: SECOND MEETING OF THE INSECTICIDE SUB-COMMITTEE, NOVEMBER, 1954.

The inaugural meeting of the Insecticide Sub-Committee was held at Morogoro in June 1954 and at the second session which met at Serere in November, it was agreed that the activities of the Sub-Committee should, in future, be reported briefly in the PESTICIDES ABSTRACTS AND NEWS SUMMARY.

The following were present at the Serere meeting:-

- Mr. K. S. Hocking, Officer in Charge, Colonial Insecticide Research, Arusha, T.T.
- Mr. K. S. McKinlay, E.A.A.F.R.O. Insecticide Entomologist, c/o Colonial Agricultural Insecticide Research Unit, Ilonga, T.T.
- Mr. D. McCrae (representing Mr. A. R. Melville), Entomologist, Coffee Research Station, Ruiru, Kenya.
- Mr. A. P. G. Michelmores, Senior Entomologist, Kawanda, Uganda. (Chairman).
- Mr. R. W. Rayner, Pathologist/Physiologist, Coffee Research Station, Ruiru, Kenya.
- Dr. R. A. E. Galley, Officer-in-Charge of Research, Colonial Insecticide Committee, London.

Members of the staff of the Serere Research Station assisted in some of the deliberations and demonstrations.

The three main items on the Agenda and the discussions and actions arising from them are summarized below.

#### 1. Design of Field Experiments

The Sub-Committee first inspected a replicated field experiment on cotton in which McKinlay's single line spraying technique was being employed.

The difficulties inherent in the design and performance of field trials were discussed with particular reference to agricultural pests in East Africa. The mobility of some of the insects, the great variations in their numbers and their movement between treated and untreated plots, frequently render the classical small plot techniques unsuitable and other methods are required to overcome or avoid this difficulty.

With Heliothis the adult may oviposit first on a plant in a treated plot and then be killed, never laying on the controls and therefore giving a false impression of the degree of control. McKinlay (E.A.A.F.R.O.) has evolved a method whereby single rows of plants are sprayed and these repel the insects into untreated plots. By this means damage on treated and untreated plants can be assessed. This method is effective in DDT experiments against Lygus but it cannot be used to measure the killing powers of different insecticides.

The difficulties in experiment design and some suggestions for avoiding them were summarised in a paper by Dr. A. C. Evans (O.F.C.) (not yet available for abstracting). It was the opinion of the meeting that more work should be done on the movement of insects in crops, possibly by "tagging" with radio-active materials and it was suggested that some of the difficulties might be avoided by carrying investigations as far as possible on a laboratory scale and then proceeding to large scale field trials.

## 2. Equipment for Applying Insecticides

Although peasant farming still occupies a prominent place in Uganda's agricultural industry some of the farmers are grouping their holdings into larger blocks through the agency of cooperative organisations or the Agricultural Department's development schemes. As a result the scope for spraying and dusting equipment is slowly increasing.

Over one hundred and ten different patterns of insecticide applicator have been assembled by the Department and their potentialities in East African farming practice are being investigated. During their stay at Serere the members of the Sub-Committee had the opportunity to inspect this equipment and to hear from Mr. T. R. Jones, the research mechanic, some of the advantages and disadvantages of the individual machines when used under African conditions. Mr. Jones had prepared a list of characters which he considered desirable in different types of machine. This list was confirmed and amplified by the Sub-Committee (see page 35 of this issue), and it was agreed that copies of the list should be sent to Mr. Mayne, Secretary of the Colonial Office Agricultural Machinery Committee, Mr. Higgins, Officer-in-Charge Colonial Office Spraying Machinery Pool, and machinery manufacturers. It was also decided that machinery manufacturers should receive copies of the reports on their particular sprayers and dusters.

## 3. Coordination of Agricultural Insecticide Work in East Africa.

The Chairman invited members to make statements summarising their current research programmes, and to these were added written statements from organisations not represented on the Sub-Committee<sup>x</sup>. In the course

<sup>x</sup> These summaries will be reproduced in the next issue of the P.A.N.S.

of the discussion members indicated the subjects upon which they would like outside help or more basic information. It transpired that some of these problems were already covered by the programmes of other organisations, but there were a number of items upon which no work was being done.

Some of the outstanding problems, and the Sub-Committee's comments on them are given below:-

- (a) General Insecticide Trials in Kenya. Dr. Le Pelley's programme contained a list of seventeen pests on which insecticide work was needed. It was felt that little direct help could be given and that Kenya would have to find its own staff to deal with them.
- (b) Coffee pests were adequately covered by the Jacaranda and Lyamungu stations.
- (c) Cereal pests. Chemical control of stalk-borers was being investigated at several places and a survey of cereal pests had been started in Uganda. Cereal pests could be used as a "research tool" by the Colonial Agricultural Insecticide Research Unit but the Sub-Committee did not support a proposal that a C.A.I.R.U. entomologist should specialise on cereals.
- (d) Methods of Sampling Insects and Tracing their movements. While the practical work of sampling might be the concern of the agricultural entomologists it was felt that the insecticide entomologists might be able to help by devising methods of sampling and particularly of tagging insects by radio-active or other means.
- (e) Machinery Studies. The Sub-Committee was of the opinion that the Colonial Insecticide Research organisation, at home and in the colonies, should undertake the task of designing new machines for special purposes. There was an urgent need for hand sprayers suitable for peasant farmers.
- (f) There was a need for more detailed information on the behaviour of insecticide particles from the time of leaving the nozzle until they arrived at the target. Physical studies at Arusha were being extended to include agricultural aspects and the Sub-Committee considered that they should be given high priority.
- (g) Insecticide Persistence was another subject of great importance and more time should be devoted to its study by the C.A.I.R.U. chemist.

- (h) Advice on Newer Insecticides. A prime function of the C.A.I.R.U. entomologists should be to sift the current literature, to select insecticides likely to be useful in East Africa, to test them in the laboratory and field against a representative range of local pests, and finally to advise the territorial entomologists on what to test out on a large scale in the field.
- (i) A study should be made of locally available dust diluents and this might well be done by C.I.R. Arusha.
- (j) Phytotoxicity. It was considered that although C.A.I.R.U. should not have a set programme on this subject, the Unit should examine and report on samples found to be phytotoxic.

(ii) REPORT OF THE SIXTH COMMONWEALTH ENTOMOLOGICAL CONFERENCE  
7th-16th JULY, 1954.

Royal 8vo. pp. iv and 344. Paper Covers. Price 30s. post free. Orders should be addressed to the Director, Commonwealth Institute of Entomology, 56, Queen's Gate, London, S.W.7.

A detailed account of the Conference, together with the conclusions and resolutions arising from it.

A memorandum of the work of the Commonwealth Institute of Entomology from 1948 to 1954 is given in Appendix I (pp. 14-21). Appendix II consists of a memorandum on the history and work of the Commonwealth Institute of Biological Control (pp. 22-26). The reports of Committees constitute Appendix III (pp. 27-33). Appendix IV (pp. 34-150) deals with the proceedings of the open meetings, which were as follows:-

| Subjects                                                                        | Openers               |
|---------------------------------------------------------------------------------|-----------------------|
| Recent Development in the Use of<br>Insecticides on Field Crops.....            | H. G. H. KEARNS       |
| Recent Development in the Use of<br>Insecticides from Aircraft.....             | D. YEO<br>R. C. RAINY |
| The Effect of the Use of Chemicals on<br>the Balance of Animal Populations..... | A. M. MASSEE          |

|                                                                   |                                                |
|-------------------------------------------------------------------|------------------------------------------------|
| The Development of Resistance to Insecticides .....               | J. R. BUSVINE                                  |
| The Supply and Training of Taxonomists .....                      | W. J. HALL                                     |
| The Estimation of Real Losses from Insect Pests .....             | I. THOMAS<br>A. H. STRICKLAND<br>Q. A. GEERING |
| The Biological Control of Insect Pests .....                      | W. R. THOMPSON                                 |
| The Biological Control of Weeds .....                             | J. R. WILLIAMS                                 |
| Pests of Tropical Cereal Crops .....                              | H. F. BARNES<br>J. BOWDEN                      |
| Development in Work on Pests of Stores Products .....             | G. V. B. HERFORD                               |
| Problems of Forest Entomology .....                               | R. C. FISHER<br>F. T. BIRD                     |
| Developments in Termite Research .....                            | W. V. HARRIS                                   |
| Developments in Locust and Grasshopper Research and Control ..... | L. G. PUTNAM<br>B. P. UVAROV                   |
| Recent Developments in Tsetse Research and Control .....          | C. H. N. JACKSON                               |

The papers read by the openers are given in full, together with summaries of the discussions that ensued.

Certain memoranda submitted in connection with the open meetings are reproduced in Appendix V (pp. 151-160).

A new innovation in the present Report is the inclusion of Reviews of Work in Economic Entomology in the Commonwealth, 1948 to 1954. There are 27 Reviews from all parts of the Commonwealth giving an overall picture of the developments that have taken place in the past six years; these are to be found in Appendix VI (pp. 161-344),

(iii) AMERICAN STANDARDS ASSOCIATION SECTIONAL COMMITTEE ON COMMON NAMES FOR PEST CONTROL CHEMICALS, K.62.

On August 17th, 1954, the American Standards Association approved the personnel of the Sectional Committee on Common Names for Pest Control Chemicals, which is referred to as Committee K.62.

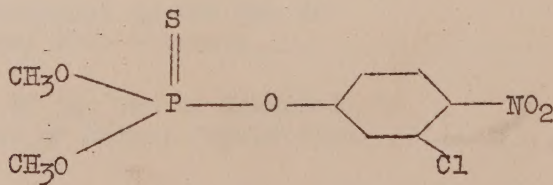
The function of this Committee will be to develop common names for pest control chemicals having potential use in pesticides including insecticides, fungicides, rodenticides, herbicides, nematocides, defoliants and plant growth regulators where such names appear desirable for popular designation of the chemicals.

This Committee, sponsored by the U.S. Department of Agriculture will have Dr. H. L. Haller as Chairman, with J. A. Noone, National Agricultural Chemicals Association acting as Secretary. The Committee is composed of representatives from U.S. Government and Trade Associations, and for Liaison purposes, a representative of the Canadian Standards Association is included.

In this country a similar Committee exists known as the Technical Committee PCC/1 - Nomenclature for Pest Control Products. This Committee, sponsored by the British Standards Institution, maintains close liaison with the American Committee and was responsible for the publication of "British Standard for Recommended Common Names for Pest Control Products B.S. 1831." Part I was published in 1952, Part II in 1953 and further lists will be published from time to time.

(iv) NEW INSECTICIDE - "CHLORTHION"

"Chlorthion" is a new organo-phosphorus insecticide developed by Dr. Gerhard Schrader of Farbenfabriken-Bayer, Leverkusen, Germany, and is the result of intensive efforts to develop pesticides with a lower order of mammalian toxicity. Chemically, "Chlorthion" is O,O-dimethyl-O-3-chloro-4-nitro phenyl-thiophosphate and has the following structural formula:



This compound is, therefore, a close relative of the dimethyl analogue of parathion.

The chemical and physical properties of "Chlorthion" are summarized below:-

"Chlorthion". Chemical & Physical Properties

|            |                                                        |
|------------|--------------------------------------------------------|
| Appearance | Brown-yellowish, viscous liquid with ester-like odour. |
|------------|--------------------------------------------------------|

|                  |       |
|------------------|-------|
| Molecular Weight | 295.5 |
|------------------|-------|

|                    |        |
|--------------------|--------|
| Phosphorus Content | 10.49% |
|--------------------|--------|

|                  |              |       |
|------------------|--------------|-------|
| Specific Gravity | $d_{4}^{20}$ | 1.437 |
|------------------|--------------|-------|

|                  |            |        |
|------------------|------------|--------|
| Refractive Index | $n_D^{20}$ | 1.5661 |
|------------------|------------|--------|

|                |             |        |
|----------------|-------------|--------|
| Boiling Points | 0.04 mm Hg. | 112°C. |
|                | 0.08 mm Hg. | 121°C. |
|                | 0.2 mm Hg.  | 136°C. |

|                 |       |                            |
|-----------------|-------|----------------------------|
| Vapour Pressure | 10°C. | $7 \times 10^{-6}$ mm Hg.  |
|                 | 20°C. | $22 \times 10^{-6}$ mm Hg. |
|                 | 30°C. | $70 \times 10^{-6}$ mm Hg. |

|            |       |                        |
|------------|-------|------------------------|
| Volatility | 20°C. | 0.07 mg/m <sup>3</sup> |
|            | 30°C. | 0.3 mg/m <sup>3</sup>  |
|            | 40°C. | 0.95 mg/m <sup>3</sup> |

Stability

- (a) Alkalies. Not stable in aqueous solutions at pH above 7.5. Hydrolyses rapidly in alkaline solutions.
- (b) Hydrolysis. Resembles that of dimethyl parathion. (dimethyl parathion has a half-life of 2½ minutes (approx.) in N.l. Alkali at 30°C.)

Compatibility

Compatible with D.D.T. lindane, TMTD, fixed coppers, wettable sulphur.

Not compatible with Bordeaux mixture, or other mixtures containing lime.

## Solubility

In water approximately 1:25,000.

Readily soluble in most organic solvents such as benzene, toluene, alcohols, ethers, fatty oils, olive oil, peanut oil. Little solubility in petroleum ether.

Methods of analysis have been developed and for residues, the method devised by Averell and Norris (Analytical Chem. vol. 20, 735, 1948) may be employed. A modification of this method for "Chlorthion" residues in milk is being prepared by Dr. M. J. Kolbezen, Citrus Experiment Station, University of California.

"Chlorthion" has been extensively tested in America, Canada and Germany for its insecticidal and miticidal effectiveness. In citrus, effective control of scale insects and citrus red mite, were obtained.

From U.S. field trials, "Chlorthion" has been found to control various cotton pests at a dosage level of 0.25 to 0.5 lb. per acre.

In fly control, this compound has been shown to be particularly promising, especially against resistant strains, and in barns, farm buildings etc., an application rate of 4 to 8 lbs. of active ingredient per 100 gallons of water, is recommended. From laboratory experiments the 50% knock-down time was found to be 50 minutes, the minimum contact time for 50% mortality within 24 hours, being 11 minutes. Topical LD50, determined by applying the toxicant to individual flies using a micro syringe, was found to be 0.28 microgram per fly. Combinations of various synergists and "Chlorthion" have been tested in the laboratory against house flies, the results obtained so far indicate that neither the knock-down effect nor the residual effectiveness of "Chlorthion" were influenced to any appreciable extent by such compounds.

"Chlorthion" has shown considerable effectiveness against mosquito larvae in laboratory experiments. Thus the following LD50 data were determined.

|                                       |              |
|---------------------------------------|--------------|
| <i>Culex tarsalis</i> (DDT resistant) | 0.019 p.p.m. |
| <i>Culex quinquefasciatus</i>         | 0.01 p.p.m.  |
| <i>Anopheles quadrimaculatus</i>      | 0.006 p.p.m. |

In field tests, "Chlorthion" effectively controlled mosquito larvae at 0.1 to 0.2 lb. of active ingredient per acre.

The mammalian toxicology of this compound has been studied with the following results: acute toxicity (LD50) when administered orally to rats, was 1,500 mg per kilogram; when administered intraperitoneally to rats, the LD50 was 750 mg per kilogram. Based on this work, it has been assumed that "Chlorthion" is not readily absorbed from the gastrointestinal tract in mammals.

The subacute toxicity has also been examined, the animals surviving daily intraperitoneal injections of 50 mg. per kilogram for a period of 60 days.

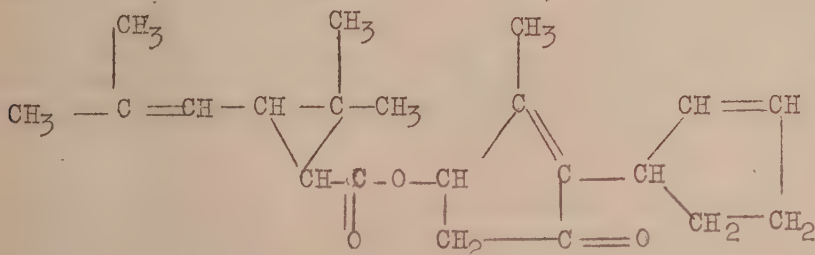
"Chlorthion" and preparations containing this compound, can be obtained in the U.K. from Baywood Chemicals Ltd., Kern House, 61-62, Lincoln's Inn Fields, London, W.C.2.

#### (v) CYCLETHRIN - FURTHER INFORMATION

With reference to News Item xi of P.A.N.S. No. 30 (old series) some further information concerning cyclothrins has now been received.

In the contributions from Boyce Thompson Institute, Vol. 18 No. 1. October - December 1954, a detailed report appears, which presents the results of laboratory tests, using this new pyrethrins-type insecticide.

Cyclothrins were synthesised by esterification of dl-cis and trans chrysanthemum monocarboxylic acid with dl-2-(2-cyclopentenyl)-3-methyl-2-cyclopenten-4-ol-one. The product was a mixture of eight possible stereo-isomers of the following molecular formula:



This compound has been found to be compatible with other insecticides and diluents commonly used in household oil sprays, aerosols and livestock sprays. Some results are also appended showing the use of cyclothrins as a grain protectant, and for this purpose, dust formulations were prepared by impregnating the wheat flour diluent with the compound from acetone slurries.

Using the rice weevil as the test insect, cyclothrins were found to be equal to allethrin when the compounds were used alone or with synergists, and in this application cyclothrins have not been synergized to a greater degree than allethrin. It is, however, emphasised that field experimentation is needed before the performance of cyclothrins can be evaluated against agricultural insect pests.

(vi) NEW SYSTEMIC INSECTICIDES TESTED AGAINST COTTON INSECTS

A recent press release by the U.S. Department of Agriculture announced promising results in preliminary experiments with mercaptomethyl dithiophosphates against cotton insects.

The two most promising compounds were:-

- |         |                                                         |
|---------|---------------------------------------------------------|
| L-11-6, | O,O-diethyl S-ethyl mercaptomethyl dithiophosphate.     |
| 12008   | O,O-diethyl S-isopropyl mercaptomethyl dithiophosphate. |

Seed treated before field planting was protected for more than a month against attack by thrips, aphids and spider mites. In the laboratory the two systemics proved lethal not only to sucking insects but also to such plant chewers as the boll weevil and cotton leaf worm.

(vii) PROPOSED AMERICAN PESTICIDE TOLERANCES AND REGULATIONS

The long-awaited tolerances for pesticides residues on fresh fruit and vegetables have now been proposed by the Food and Drug Administration of the Department of Health, Education and Welfare and have been published in the U.S. Federal Register, Vol. 19, No. 204, October 20th, 1954 (National Archives, Washington, U.S.A.). At the same time the H.E.W. department has laid down proposed regulations on operational procedures.

It is emphasized that the schedule of tolerances, (reproduced in part on pages 19-41), is tentative, and is subject to review and change. These tolerances are based on scientific information developed at the hearings held in 1950. Parties who appeared at these hearings are allowed 60 days to file exceptions to the proposed schedule of tolerances. The proposals for operating procedures are subject to a similar period of time, for interested persons to submit their views, and they may request a hearing if desired.

The proposed schedule provides that no residues of the following pesticides shall be allowed to remain on fruits or vegetables:

- Calcium Cyanide
- Dinitro-ortho-secondary-butylphenol
- Dinitro-ortho-cresol
- Tetraethyl pyrophosphate (TEPP)
- Hydrocyanic acid
- Mercury containing compounds
- Nicotine and nicotine - containing materials
- Selenium and selenium containing compounds

It is clear that with some of these compounds, such as calcium cyanide and hydrocyanic acid, for example, a zero tolerance will have little or no effect upon the manner in which they are employed in agriculture, since they are usually applied to crops at such a time in their growth or are lost so rapidly after application, that this requirement can be easily complied with. On the other hand, mercury and selenium compounds must be used with unusual care to ensure finished crops from bearing any residues when marketed.

In a number of cases the evidence received in the 1950 hearings was insufficient to permit the establishment of a satisfactory tolerance. Applications to establish tolerances for these pesticides and for new compounds, or to revise existing tolerances, would be dealt with under the new Miller amendment.

Under the new law the proposed regulations would:

1. Set up exemptions for a group of common pesticides which are entirely safe on growing crops. Examples of this group includes petroleum oils, pyrethrum, rotenone, ryania and sabadilla. This exemption does not apply when this group is used at time of harvest or just after
2. Set up procedure for the appointment, by the department, of experts selected by the National Academy of Science to committees to advise the Department in regard to controversial scientific questions arising in the establishment of tolerances. Under this new law, the Secretary of Agriculture is required to certify whether a pesticide chemical is useful in agricultural production before the Secretary of Health, Education and Welfare is required to act upon a petition to set up a tolerance for that chemical.

An abridged version of the Table of Proposed Tolerances is given in SUPPLEMENT II, pages 39-41 of this issue of P.A.N.S.

(viii) SYNTHETIC MEDIA DEVELOPED FOR LABORATORY REARING OF PINK BOLLWORMS AND BOLL WEEVILS.

Report of the Administrator of Agricultural Research, 1953, p.259.  
United States Department of Agriculture.

For the first time the pink bollworm has been reared from egg to adult on a medium in which all components are known and are chemically pure. This medium is composed of dried egg albumin, dextrose, cottonseed oil, and crystalline vitamins. Physical conditions necessary for the development of the insect were also determined. The shortest period for development from egg to adult was 41 days. The average development period in the field is about 31 days.

Starting with half-grown larvae, normal adult boll weevils were also produced in a synthetic medium. Crystalline vitamins, purified dried-egg albumin, dextrose, fats, salts, and water were combined to produce a homogenous, solid, soft medium suitable for their development. Larvae were observed to feed and prepare a hollowed-out space in the medium for pupation, similar to that in a square boll. Normal pupation and emergence occurred.

(ix) A BIBLIOGRAPHY FOR SYSTEMIC INSECTICIDES. E-874: MARCH, 1954.

This bibliography has been compiled by PAUL A. GIANG, Entomology Research Branch, United States Department of Agriculture. An attempt has been made to include all the references on the chemistry, pharmacology, and insecticidal testing of systemic insecticides that appeared in the literature up to December 1953. It does not include references to systemics tried on animals only. The 455 references are arranged alphabetically according to authors and the insecticides mentioned in each reference are indicated by means of a numerical key.

(x) LEPIDOPTEROUS STALK BORERS

From time to time the Commonwealth Institute of Entomology issues publications dealing with special topics, these sometimes take the form of a review of the literature e.g. "Association of Ants with Aphids and Coccids", by G. E. J. Nixon (1951), or they may present a catalogue of pests associated with a particular crop, e.g. "List of Sugar-Cane Insects, by H. E. Box (1953).

The latest title to be added to this series is, "A Critical Review of the World Literature on the LEPIDOPTEROUS STALK BORERS OF TROPICAL GRAMINACEOUS CROPS", which has been prepared by W. F. Jepson B.E., Ph.D.

In the opening paragraph to the preface to his work Dr. Jepson states: "In undertaking this Review, the writer has been moved primarily by the conviction that the problem of stem-boring insects in the important graminaceous food crops of the tropics - rice, maize, the millets, and sugar-cane - is a chronic, serious, and often discouraging item in the programme of many Departments of Agriculture. Chronic, because the stalk borers take a steady if unspectacular annual toll; serious, because they are an obvious factor in reducing yields which are already pitifully insufficient and discouraging, because in spite of a large amount of study, no sound basis of control has yet been formulated which can be generally applied".

Most agricultural officers and entomologists working in the tropics will concur with these sentiments and will welcome this carefully planned and executed work by an entomologist with first hand experience of the problem. Dr. Jepson has drawn largely on the summaries of papers appearing in the Review of Applied Entomology up to the end 1953, but the references given at the end of the review are in most cases those of the original papers.

The review, comprising vi + 127 pages is arranged in eight sections which may be summarised as follows: 1. Historical, 2. Identification, 3. Hosts, 4. Bionomics, 5. Population estimation and damage assessment, 6. Relation of borers to cultural practice, 7. Parasites, predators and diseases, 8. Control. At the end of section 8 the author gives his conclusions, following the same pattern as in the body of the Review and pointing out the gaps in existing knowledge and broadly indicating the directions in which he considers research should proceed.

The Review costs 15/- and may be ordered from the Director, Commonwealth Institute of Entomology, 56, Queens Gate, London, S.W.7, or through a bookseller.

(xi) FUMIGATION WITH METHYL BROMIDE UNDER GAS-PROOF SHEETS

W. BURNS BROWN (1954). Pest Infestation Research, Bulletin No. 1. (D.S.I.R.) Obtainable from H.M.S.O., London. Price 2s. 6d. net.

Extract from preface:-

"The method of fumigating large quantities of bagged or cased commodities under an envelope of gas-proof sheeting has proved to be of considerable utility in Great Britain and in West Africa and it is being adopted in other African territories. The fumigant preferred is methyl bromide. Much remains to be learnt about the use of the method in differing circumstances but it has already been shown to have a wide applicability. The method should prove of particular value in countries where facilities for other methods of fumigation are very limited or non-existent. This pamphlet aims to provide the information which has so far been accumulated as a result of using the method in Great Britain and Africa. It also indicates ways in which the effectiveness of the treatment can be assessed so that any who adopt the method will be better able to adapt and improve it to suit local conditions.

Most of the advice in this pamphlet is based on experience in the treatment of bagged grain and it is likely that the method will continue to have its widest application in the disinfection of this product. However, brief reference is made to the treatment of other products."

The bulletin contains 38 pages plus 8 pages of photographs and is divided into three main sections. The first section describes the physical and chemical properties of methyl bromide, the effect on fumigated foodstuffs and precautionary measures which must be adopted.

The method of fumigating under sheets is then described in outline and details are given on various aspects, such as the types of stack suitable for fumigation, equipment, piping and sheeting of stacks, dosage, and procedures for applying the fumigant and for airing. This second section also contains a list of equipment required for fumigating a 500-ton stack and specimen instructions for the operator-in-charge.

The third section deals with methods for determining the effectiveness of a fumigation.

(xii) THE AFRICAN ARMY WORM AND ITS CONTROL

J. A. WHELLAN., Bulletin No. 1792. Ministry of Agriculture and Lands, Salisbury, Southern Rhodesia.

This bulletin is, in fact, a reprint of the paper from "Rhodesia Agricultural Journal" Vol. 51 No. 6. November - December 1954.

The author deals in some detail with the life history of this pest and several photographs of larval and adult stages are included.

Methods of control which are discussed include brief descriptions of the natural enemies of this insect, followed by a short discussion on the use of synthetic insecticides.

The following sprays were found to give a complete or almost complete kill of Army Worms at all stages:

|                               |                             |
|-------------------------------|-----------------------------|
| DDT 27.5% emulsion            | 5 pints in 100 galls. water |
| DDT 50% wettable powder       | 3 - 4 lbs. " " " "          |
| BHC cattle dips               | 5 lbs. " " " "              |
| Aldrin 25% wettable powder    | 2 lbs. " " " "              |
| Chlordane 100%                | 1 lb. " " " "               |
| Parathion 15% wettable powder | 1½ lbs. " " " "             |
| Toxaphene 70% cattle dip      | 3 - 4 pints " " " "         |

Application rates were at 100 gallons of diluted formulation per acre. A DDT dust containing 5% or 2½% DDT may also be used at the rate of 15 to 20 lbs. per acre. When proper dusting equipment is not obtainable, the dust may be placed in a pillow case and beaten out from the back of a slowly moving tractor. BHC dusts can be used in much the same way.

The author considers that dieldrin, endrin and malathion would also prove effective, although they have not been tested for this purpose in Southern Rhodesia.

## ABSTRACTS

### 55/1 CONTROL OF BITING FLIES BY INSECTICIDAL METHODS IN UGANDA. PROGRESS REPORT No. 1. (SEPTEMBER-DECEMBER, 1954).

H. C. M. PARR. Entomologist, Colonial Insecticide Research,  
Animal Health Research Centre, Entebbe, Uganda.

As originally envisaged, in 1950, it was intended that this research scheme should be confined to the geographical and seasonal distribution of Stomoxys species and their possible role in the transmission of trypanosomiasis. Recent work (Lucas 1955 (in the press)) confirmed the possibility of mechanical transmission by Stomoxys species and emphasised the need for similar work on other genera. The original plan was therefore extended to include the Hippoboscidae and the Tabanidae.

Accommodation for this work has been kindly provided by the Director of Veterinary Services, Uganda and the equipping of laboratory and offices is well in hand. While awaiting the completion of this work the Entomologist has carried out various surveys in the Entebbe peninsula, Kawanda Agricultural Research Station, the Iriri district of Karamoja, the Agricultural Research Station at Serere, and the Mbarara district. A line survey was made en route from Entebbe to Mbarara, via Mpigi and Masaka.

The progress report gives a list of the places surveyed, with map references, the names of species captured, time of capture, topography of place, weather conditions prevailing at the time of capture, prevalence of species captured and conditions of capture.

The species collected were:-

*Stomoxys calcitrans*, *S. nigra*,  
*Haematopota vittata*,  
*Hippobosca maculata*,  
*Tabanus taeniola variatus*, *T. lubutiensis*,  
*Chrysos distinctipennis*,

In addition to the above, 4 different species of *Haematopota*, 7 specimens of *Stomoxys* and 2 different species of *Tabanus* had been collected but still awaited identification.

E. J. PAMPANA. Malaria Section, World Health Organization.  
(The following summary appeared in Chronicle of the World Health Organization, 1954, vol. 8, No. 11, pp.328-330, and the complete paper in Bulletin of the World Health Organization, 1954, vol. 11, No. 4-5, pp.513-520).

Malariologists and public-health services would be able to view with complete satisfaction the remarkable results of malaria control by means of DDT, which has been in progress for about ten years, if recent developments did not call for a revision of the present strategy.

By house-spraying with residual-action insecticides, one can aim not only at controlling malaria, but even at eradicating it. This, of course, does not mean or require eradication of the vector; it only means eradication of the malaria parasites. If transmission does not take place, malaria dies out spontaneously. Infection with Plasmodium falciparum generally lasts no longer than one year; with P. vivax, generally lasts no longer than two, or, exceptionally three or four. Only infection with P. malariae may persist throughout life, but it is not known for how many years it remains infective for the mosquitoes. Disregarding infection with P. malariae, which is by far the rarest of malaria infections and in many places is not present at all, it must then be admitted that, once the transmission of malaria in a country has been completely stopped for three or four years, there will be no more malaria parasites in the human or the mosquito host. Malaria control can then be withheld, provided the country concerned is protected from reimportation of parasites.

Certain countries have already achieved this objective. It was in 1953, in view of the experience of certain countries, particularly Greece, the Expert Committee on Malaria concluded that "the practice of discontinuing residual spraying, under proper safeguards, after several years of achieved malaria control, is both logical and feasible...."1). It was thus recognized that expenditure on malaria control might be lightened after a few years, a consideration of great importance for highly malarious countries.

However, the requisite conditions for discontinuing residual-insecticide spraying are not fulfilled everywhere; in fact, few countries would be justified in discontinuing it at present. First of all, the discontinuation requires that transmission has not occurred for several years and therefore that malaria parasites in man or mosquito no longer exist in the given area. Further, the area where this end-point of transmission has been reached and maintained must be a major part of the territory, possibly so outlined as to have no endemic malaria on its border or within them.

In planning for the interruption of insecticide spraying, various conditions must be borne in mind. First, within the area to be controlled, every locality where transmission is possible should be under control. Secondly, the assessment of the results should make it possible to determine accurately if and where total interruption of malaria transmission has been achieved. Current methods of assessment do not always seem sufficiently sensitive for this purpose: infant parasite-rates may have reached zero though some transmission is still occurring. Therefore, the localities should be visited regularly, and all subjects having fever or having had fever during the intervals between visits should have their blood examined. Such examinations, which are being carried out in Greece, should start at least one year before interruption of the spraying campaign is envisaged. Thirdly, malaria control should be undertaken with the greatest technical thoroughness, all at one time and in as large an area as possible, preferably bordered by areas where, naturally or as a result of control, there is also no transmission. The greater the extent to which adjacent areas or countries have been subjected to similar malaria-control measures, the less will be the danger of reintroduction of parasite carriers.

The resistance of insects to insecticides now complicates the planning of malaria-control programmes. Although "behaviouristic resistance" may not interfere with malaria control, acquired physiological resistance, when high, is bound to interfere. According to recent information from Greece, not only A. sacharovi, but also A. maculipennis and A. superpictus have developed some degree of DDT resistance. Evidence seems to indicate that in certain villages DDT failed to prevent transmission.

If this danger is ignored, resistance may develop after a large-scale programme has been under way for some years, may extend to other chlorinated-hydrocarbon insecticides, and may make necessary the use of other more dangerous and more costly insecticides. Health services may also have to avail themselves of the techniques of malaria control used previously, which, although more effective today than formerly, because of the new antimalarias now available, would be applied to populations which had lost the natural immunity conferred by endemic infection. To heed the warning from Greece means to plan the programme in such a way that house-spraying can be safely discontinued before insecticide resistance develops. The larger the area throughout which the end-point of transmission is attained at the same time, the more safely can the spraying be discontinued. To prevent the development of resistance, indiscriminate spraying and the use of the insecticide for larval control should be avoided.

It is realized that this new strategy, which must be applied to huge areas and which calls for thorough control for a number of years, will require more money, more trained personnel, greater efficiency of operations, and better systems of epidemiological surveillance than are

necessary now. These difficulties would be counterbalanced by better and quicker results, and by the hope of seeing malaria become a less heavy burden on the budgets of health administrations after a few years. Should this strategy not be adopted, it is possible that house-spraying might remain effective but would have to be continued year after year; it is also possible, however, that resistance to insecticides might develop in anophelines, increase, become polyvalent, and lead to the ultimate failure of the whole programme.

(1) Wld. Hlth. Org. tech. Rep. Ser. 1954, 80, 24.

### 55/3 THE PREVENTION OF TERMITE DAMAGE TO BUILDINGS

W. V. HARRIS, Officer in charge, Colonial Termite Research Unit.  
Colonial Building Notes No. 26. January, 1955.  
Dept. Scientific and Industrial Research.

Largely due to alterations in the circumstances, termite damage to buildings in the Tropics has been brought into greater prominence.

Thus, the high cost of building, refinements in design, a greater use of imported timber, and the greatly increased cost of repairs have all contributed to emphasise the importance of this problem.

Killing termites is only of value when the colony as a whole is engaged, while protection is a matter of resistance to the long drawn out probing, as of sappers in a siege.

The food of termites is solely plant material of a woody nature - timber, grass stems, the droppings of herbivorous animals, paper, cellulose acetate fabrics, and in their search for food, termites may gnaw through thin layers of relatively soft materials such as lead or various plastics, but this form of attack is infrequent.

In order to better consider the methods of prevention and control, it should be borne in mind that there are two groups of termites, i.e. "subterranean termites" and "dry-wood termites". The former are the commonest, most varied in behaviour and the most destructive. Nests are built below ground, although a few make nests of clay and chewed wood on the trunks and lower branches of trees with connections to the ground. Subterranean termites can be kept out of buildings by the use of mechanical barriers, although they will exploit to the full any way of getting round such precautions.

Dry-wood termites live, without any connection with the ground, inside dry timber on which they feed as they bore their way along, after the manner of timber beetles. When dry-wood termites swarm, they

fly straight into the roofs of buildings and start new colonies inside the timbers there, or descend to the furniture if it has not been impregnated with suitable chemicals.

The following suggestions based on general principles are offered in connection with the design and construction of termite-proof buildings.

Site clearance is a necessary preliminary to building in all areas where there are subterranean termites, and especially in dry countries where shortage of food soon drives termites to seek out constructional woodwork. The building plot should have all dead wood and old tree stumps dug up and removed for at least 20 feet beyond the foundations. A careful examination of the site should be made for termite mounds and for those holes on the surface which indicate a termite nest below ground. If there are signs of living termites the nests must be destroyed with an arsenic and sulphur smoke machine, or by using a suitable fumigant such as petrol, carbon disulphide or DD mixture.

If there is not a continuous concrete slab across the foundations to form a barrier against any upward movement of termites from the soil, it is advisable to poison the surface layer of the soil within the limits of the foundations. This can be done, by impregnating the surface carefully with a 5% solution of pentachlorophenol in fuel oil, or a similar strength solution of sodium pentachlorophenate in water. The oil solution is however preferred, since leaching out of the water soluble sodium salt can impair its effectiveness. It takes a minimum of 4 gallons of solution per 100 square feet of soil surface to produce an adequate layer of poisoned soil.

The use of barriers is considered well worth-while and the value of metal "ant guards" has been found effective in a number of buildings in East Africa, although it is stressed that opinion on this topic, is divided.

In areas where dry-wood termites exist, structural timbers require to be made termite proof. This means, of course, that the timber must receive some impregnation treatment prior to its use in construction.

The most important part about wood impregnation, irrespective of what chemical is used, is to ensure that penetration is adequate to produce "defence in depth" and not merely a superficial appearance of protection.

On the question of resistant timbers, the writer considers it is doubtful if any one timber will remain immune to all varieties of termites after twenty or thirty years. Hardwoods like teak, mahogany, and iroko are highly resistant to all subterranean termites, but after a time it would appear that some of the dry-wood species can make headway in them.

Experience has shown, however, that the heart wood of local timbers is reasonably resistant for constructional work in buildings. In their absence, impregnated timber is advisable anywhere between 40 degrees north and south latitudes, and from sea-level to seven thousand feet.

55/4 THE EUROPEAN HOUSE-BORER HYLOTRUPES BAJULUS (L.) (COLEOPTERA: CERAMBYCIDAE) AND ITS CONTROL IN THE WESTERN CAPE PROVINCE

H. J. R. DURR. (1954). Bulletin No. 337. Department of Agriculture, Union of South Africa.

This bulletin deals with its subject in a very comprehensive manner and covers at some length such aspects as economic importance, distribution, material attacked, systematics, and natural enemies; the section on the control of the pest is particularly detailed.

Investigations on control measures were started during the summer of 1943-1944, the initial research being concerned with the use of pentachlorophenol solution. A new titrimetric method is described for the estimation of small quantities of this compound. The rate of absorption of pentachlorophenol by pine timber was investigated, and it was shown that absorption is very rapid during the first two minutes, afterwards proceeding less rapidly.

The effects of various insecticides on the eggs, larvae and adults were investigated. Adults are not so strongly repelled by insecticides that no eggs will be deposited on treated wood, and eggs were deposited in the presence of timber which had been treated with 8 types of insecticides. In some cases, the females were killed so rapidly that no eggs were deposited. In the case of insecticides possessing a strong contact action, the hatched larvae were unable to penetrate the treated wood.

It was thus found that the substances tested could be divided into two sharply defined groups. Those possessing a strong contact action included pentachlorophenol, creosote, DDT and BHC, and those with only a very weak contact action, viz. zinc sulphate and copper naphthenate. Wolman salt (a proprietary formulation containing sodium fluoride, DNC, potassium dichromate and sodium arsenate) occupies an intermediate position between these two groups.

Complete control of larvae in wood by fumigation with methyl bromide at atmospheric pressure was obtained at concentrations normally used for fruit fumigation. Vacuum fumigation gave complete control in about a 1/6th of the time, and is suggested for the control of Hylotrupes bajulus in furniture and other structures, where surface treatments may not be possible.

5% pentachlorophenol solution is recommended for treating timbers in roofs, or floors and is superior to either DDT or BHC for this purpose.

Copper naphthenate was found to be more toxic than the corresponding zinc salt.

A mixture of 2% pentachlorophenol and 3% zinc naphthenate was more toxic to larvae than 5% pentachlorophenol alone. BHC remained toxic to larvae for a period of 3 years in wood blocks stored under room conditions for this period.

The author concludes that of all the substances tested, the two most closely conforming to the requirements for a good timber preservative are the following:

5% zinc naphthenate in a 50:50 mixture of white spirit and power paraffin.

3% zinc naphthenate + 2% pentachlorophenol in a 50:50 mixture of white spirit and power paraffin.

#### 55/5 THE BEHAVIOUR OF LINDANE DURING THE MILLING OF WHEAT TREATED WITH THIS PRODUCT

Ing. P. MAITHA. Laboratoire de la Koninklijke Industriele Maatschappij v/h Noury & Van der Lande N.V. - Deventer.

Presented at the Tenth International Agricultural Congress - Madrid, June, 1954.

This paper presents the results of research work on the behaviour of lindane during the milling of grain which has been treated in bulk with this insecticide.

Determinations were made using the Schechter and Hornstein colorimetric method, which is based on the reduction of gamma BHC to benzene by zinc and acetic acid.

In the present work, this method was used with the addition of a cleaning agent to the distillation column and the nitration column to facilitate the cleaning of the apparatus. Estimation of the colours developed was carried out with a "Lumetron" photo-electric colorimeter, using a 575 filter.

The lindane in the grain was estimated by direct determination, since solvent extraction with chloroform produced coloured blanks which upset the subsequent measurement of actual colours developed. Thus

10 grams of wheat or flour were mixed with 2.5 grams of malonic acid, 2 grams of zinc and 20 ml. of glacial acetic acid, and the procedure of Schechter and Hornstein was followed without further modification.

It is stressed that all the reagents used, particularly the nitration liquid, should be very pure, and attention is drawn to the fact that this determination is not specific for gamma BHC, so that all reactions producing benzene by reduction will give a positive reaction. It is recommended that blank determinations on untreated material should be carried out.

After some small scale laboratory treatments of grain, some large scale trials were carried out as follows:-

A quantity of grain was treated at the rate of 250 grams per ton with an insecticide formulation containing 1.75% of lindane. Following this treatment the grain was stored in a silo for a month. The wheat was then cleaned in the normal way and milled to an extraction rate of 78%, samples being taken at various stages. Lindane and ash contents of these samples were determined, with the following results:-

|                                                     | % ash as<br>dry material | BHC<br>mg/kg |
|-----------------------------------------------------|--------------------------|--------------|
| Wheat before cleaning                               | 1.9                      | 2.5          |
| Wheat after aspiration                              | -                        | 2.3          |
| Wheat after aspiration, washing<br>and conditioning | -                        | 2.0          |
| Wheat before milling                                | -                        | 2.0          |
| Flour from first break                              | 0.53                     | 0.3          |
| " " third "                                         | 0.54                     | 0.0          |
| " " fifth                                           | 1.41                     | 0.6          |
| " " first reduction                                 | 0.42                     | 0.0          |
| " " third "                                         | 0.40                     | 0.0          |
| " " sixth "                                         | 0.88                     | 0.7          |
| " " ninth "                                         | 2.86                     | 1.9          |
| " " eleventh "                                      | 4.84                     | 2.5          |
| " " thirteenth "                                    | 6.10                     | 4.0          |
| Bran                                                | 8.11                     | 3.8          |
| Tailings                                            | 5.79                     | 4.6          |
| 78% extraction flour                                | 0.78                     | 0.9          |

From these results, it can be seen that cleaning the grain eliminated about 20% of the gamma BHC present. The flour of the first break tained a small quantity of gamma BHC and that of the third break contained no BHC. This is explained by the fact that the dust adhering to the grain especially in the groove is retained by the flour in the first break. Flour from the second and third breaks is generally a little cleaner.

Since samples were not taken from all the milling stages, it was not possible to establish an exact balance sheet for gamma BHC. It does appear possible, however, that part of the lindane is volatilised in the course of milling, since during the passage through the mill rolls, the flour is heated several times and intensively aspirated with air.

The main conclusions from this research appears to be that prime flour from lindane treated grain is free from residual amounts of lindane, and that flour with an extraction rate of 78% contains only 0.9 mg. per kg. (0.9 p.p.m.).

#### 55/6 THE SWEETPOTATO WEEVILS IN HAWAII: THEIR BIOLOGY AND CONTROL

M. SHERMAN and M. TAMASHIRO (1954). Hawaii Agricultural Experiment Station, University of Hawaii, Technical Bulletin No. 23.

The bionomics and control of the two sweetpotato weevils, Euscepes postfasciatus (Fairm.) and Cylas formicarius elegantulus (Summ.) were investigated under laboratory and field conditions. These insects are the most destructive pests of sweetpotatoes in the Hawaiian Islands. Their damage causes the potato to be unmarketable and even unpalatable to livestock.

The eggs of the weevils which are laid singly in the vine or root are covered with a fecal plug. The egg period is approximately 8 days.

The larvae of the two species are very similar in appearance but can be separated by certain chaetotaxic characters of the head. There are five larval instars in Euscepes postfasciatus and three in Cylas formicarius elegantulus. At a mean temperature of 80.3°F. the larval period in E. postfasciatus ranged from 18 to 24 days, while in C. formicarius elegantulus it ranged from 15 to 20 days.

Pupation occurs within the root or stem. There are definite colour changes that can be correlated with the age of pupa. The average pupal period is 9 days in Euscepes postfasciatus and 8 days in Cylas formicarius elegantulus.

The adult Euscepes postfasciatus is a small, brownish or greyish weevil, while the adult Cylas formicarius elegantulus is larger and a bright red and blue colour. When food and water were withheld from the newly emerged adult, both species survived for about a month. Both species will feign death when disturbed, and this habit makes detection of the weevils in the field extremely difficult.

The major means of infestation of a field are probably by means of infested cuttings and adults crawling from adjacent fields.

Euscepes postfasciatus does not fly, and Cylas formicarius elegantulus flies infrequently. Infested volunteer sweetpotatoes within a field are a source of infestation for subsequent planting. No effective natural or biological control of these weevils are known.

Cultural control methods are discussed.

The relative susceptibility of the two species of weevils to nine synthetic organic insecticides was determined. The order of toxicity of the insecticides to Euscepes postfasciatus are: aldrin = dieldrin > parathion > endrin > isodrin = lindane > chlordane > toxaphene = pp' DDT. The order of toxicity of the insecticides to Cylas formicarius elegantulus are: parathion > endrin = isodrin > lindane = aldrin = dieldrin > pp' DDT > toxaphene > chlordane.

The results of the field trials on the chemical control of the weevils are discussed. Insecticides were applied as sprays, dusts, and soil treatments. DDT applied as a preplanting cutting dip in combination with sprays at 10 and 16 weeks after planting at the rate of 2 pounds of active ingredient per 100 gallons gave excellent control. DDT dusts were inferior to sprays. None of the chemical treatments resulted in off-flavour in the sweetpotatoes.

55/7 THE P<sup>32</sup> MARKED DIETHYL THIONOPHOSPHORIC ESTER OF  $\beta$ -OXYETHYL THIOETHYLETHER (ACTIVE INGREDIENT OF THE SYSTEMIC INSECTICIDE "SYSTOX") ITS ABSORPTION AND TRANSLOCATION IN PLANTS

H. TIEFZ. (1954). Höfchen-Briefe, Vol. 7, No. 1, 1-55.  
(English edition published by Bayer, Plant Protection Department, Leverkusen, Germany).

This paper describes some original work on the translocation in plants of "Systox" containing radioactive phosphorus as a marker.

A liquid counter tube in the Geiger-Müller counter apparatus, made it possible to detect quantities of the insecticide which were well below the value accepted for insecticidal efficacy. Thus although a concentration of  $5 \times 10^{-6}$  was sufficient to kill aphids, dilutions of  $1 \times 10^{-9}$  could be traced physically.

It was found that the active ingredient of "Systox" was absorbed freely from a solution by the intact plant root, but the absorption from sand and humus-containing soils was a slower process, and is effected only up to certain limited concentration which differs for each type of soil. When the active ingredient is absorbed from a soil, the permeability of the root for water increases over a long period, only

to drop later below the normal value, finally adjusting itself to its original permeability. Certain quantities of the active ingredient are excreted by the root, into the surrounding soil.

After absorption by the root, the active ingredient is translocated through the medium of the transpiration stream to shoots growing above ground, where it is accumulated to a greater extent in the regions of the leaf periphery rather than in the centre of the leaf, and storage of the active ingredient in the leaves is, in any case, only of temporary duration.

When "Systox" is applied to the leaves by means of a spray, the active ingredient is able to penetrate into the interior of the leaf at a higher concentration than occurs when the insecticide is applied to the roots.

When single leaves are treated, the active ingredient moves to the untreated parts of the plant, this movement being more extensive in the apical direction than in the basal direction.

The phloem is primarily responsible for the translocation of the active ingredient following a treatment of the shoot parts growing above ground, although certain quantities also pass into the xylem.

Autoradiographs of leaf cross-sections showed that there are particularly large accumulations of active ingredient in the epidermises and in the cells of the connecting bundle parenchyma.

The detoxification of the plant takes place chiefly as the result of recretion (i.e. excretion of the active ingredient).

The active ingredient molecules are trapped in the extra-vascular membrane stream and exude through the pores of the cuticle, to the surface of the leaf. The active ingredient is finally removed from the surface either by rain or as a result of evaporation.

## 55/8 POSITIVE-FLOW BAND APPLICATOR FOR GRANULAR SOIL INSECTICIDES

H. ANDERSON..(1954). Publication No. 916. Canada Department of Agriculture.

The applicator described in this paper can be made fairly cheaply and was built for use during experiments with soil insecticides for the control of root weevils and the narcissus bulb fly.

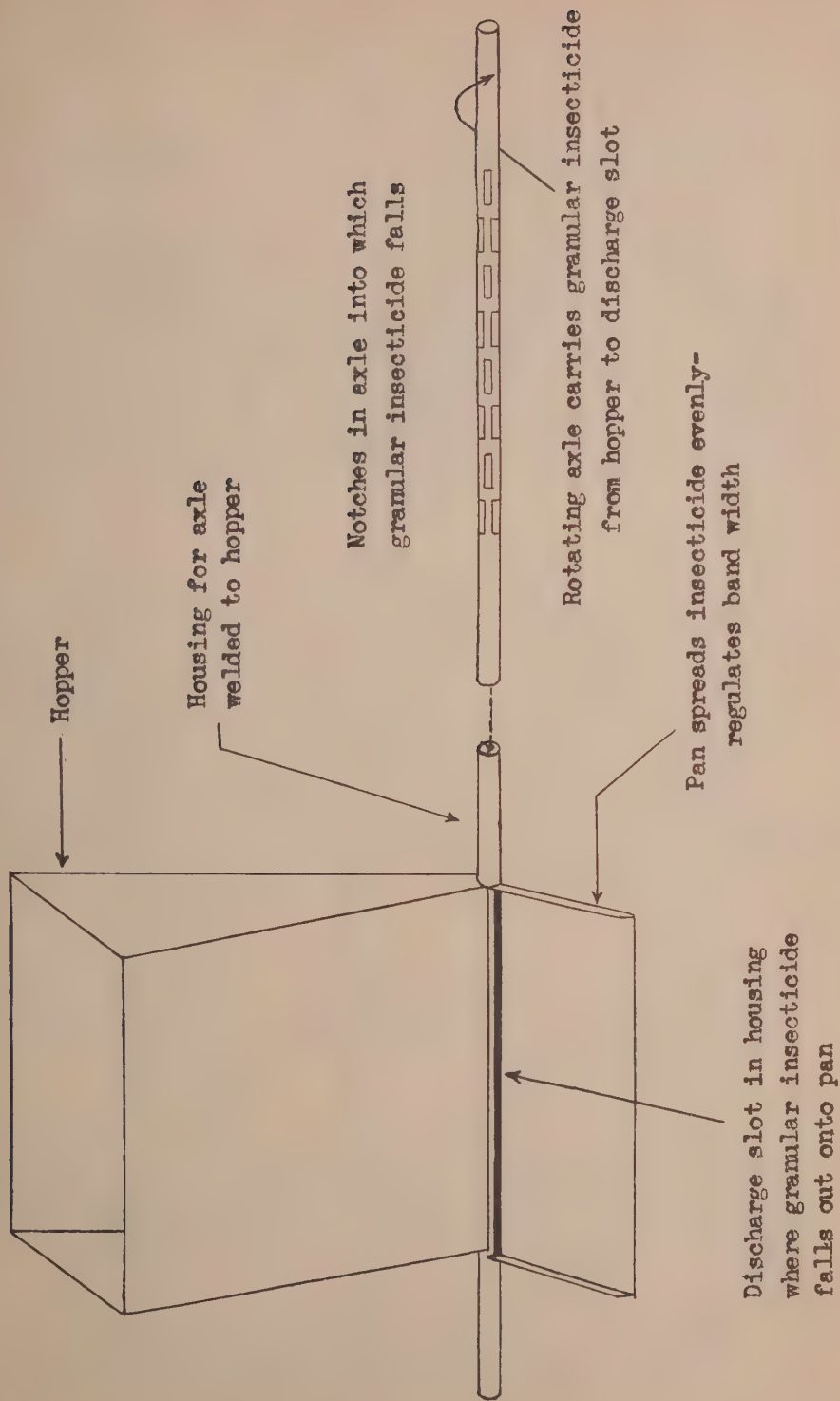
In the main, the applicator consists of a V-shaped galvanized metal hopper on wheels. As the axle revolves, notches in the axle meter the

flow of the granules. The model which was constructed first had a hardwood axle, the notches in it having been cut out with a chisel.

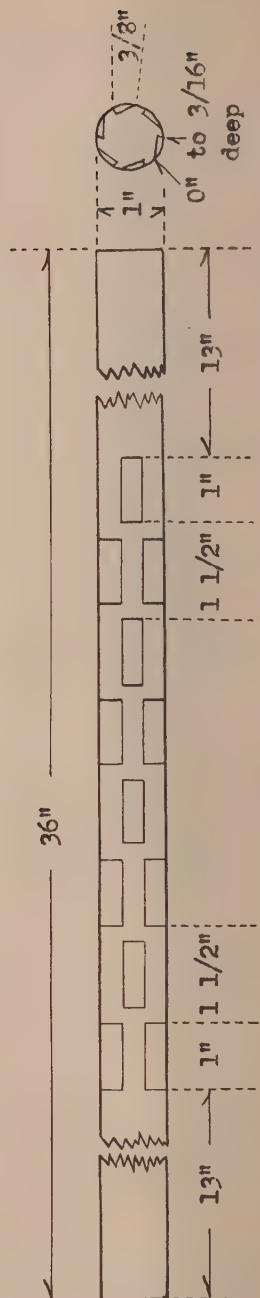
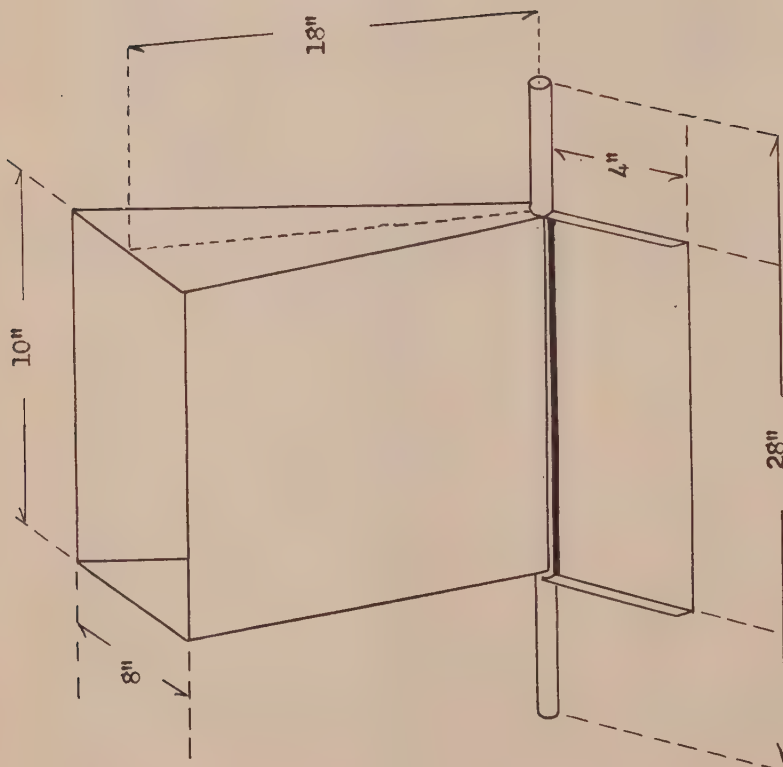
As can be seen from the accompanying drawings, the applicator applies the insecticide in a 10-inch band. The hopper is 10 inches long, 8 inches wide at the top and 18 inches deep, with a capacity of about 20 pounds of granular insecticide. A one-inch galvanized pipe, acting as a housing for the axle, is welded to the bottom of the hopper. It has two slots in it 10 inches long and  $\frac{5}{8}$ " wide. The granules drop through the top slot into the notches and are metered by the revolving axle; they pass on through the bottom slot and on to a 4" x 10" pan attached to the bottom of the hopper. This pan, attached at an angle of  $45^{\circ}$  spreads the insecticide evenly and regulates the band width. The axle has 24 notches, six rows of four each, placed in line, the notches being  $1\frac{1}{2}$ " apart in the row. Each notch is 1" long,  $\frac{3}{8}$ " wide, and  $\frac{3}{16}$ " deep at the trailing edge. Wheels, made of  $\frac{3}{4}$ " plywood are held in place on the axle by metal collars and a set-screw. With 18" diameter wheels, the applicator applies 1 pound of 30-60 mesh granular insecticide per 50 yards in a 10 inch band. When the bands are 3 feet apart, this applicator applies 100 pounds per acre. Using 10" diameter wheels, the same axle applies 150 pounds per acre. A lawn mower type of handle is attached to the axle housing and braced to the back of the hopper.

The principal advantages of this applicator are: calibration can be easily accomplished by using wheels of various sizes: the rate of application per acre can be decreased by using wheels of larger diameter: discharge rate is uniform, whether uphill or downhill, at low or high speeds and with the hopper full or almost empty.

# Granular Insecticide Applicator (with wheels and handle removed)



# Dimensions of Granular Insecticide Applicator



J. LANDRETH. (1954). Tea Quarterly. (Ceylon), vol. 25, pt. 1, pp.15-16.

A power operated charge pump unit tested out on St. Coombs Estate during the past six months has proved to be highly satisfactory.

Since a considerable amount of labour and time is expended in charging knapsacks by hand-operated pumps, especially when nozzles having outputs of up to 20 gallons per hour at the normal knapsack working pressure are used, the advantages of power charging are obvious. The daily spraying task on St. Coombs requires 600 gallons of water and since the tank on the unit has a capacity of 200 gallons a tractor must be available at specified times to move the unit to points convenient for re-filling and for operating. Although the tractor is used mainly for leaf transport no difficulty has been experienced in co-ordinating the two duties.

The unit consists of a channel iron chassis fitted with axle, wheels and brakes. The brake lever is positioned for operation from the tractor seat. The fore-end of the chassis is designed for use with the automatic hitch assembly on a ferguson tractor. Mounted on the chassis in a 200 gallon tank and a pumping group. A framework, fitted with base blocks and straps to position each knapsack, surrounds three sides of the tank. The number of knapsacks carried is 16. A metal tray is fitted on top of the tank to carry hoses and lances, also a 3 gallon mixer for the fungicide. The pump and motor were supplied by Messrs. Cooper, Pegler & Co. Ltd., England and their specification is as follows:-

x CHARGING GROUP No. 647

3 h.p. 4 stroke engine.  
2 throw high pressure pump.  
Output 6 gallons per minute.  
Pressure up to 200 lbs. per square inch.  
Belt driven.

This group, designed for charging batteries of "Favori-Colibri" knapsacks, consists of a powerful belt driven liquid pump and air compressor mounted on a strong chassis. It is fitted with handles for the mounting of bearers if necessary. The air compressor will charge one "Favori-Colibri" with up to 70 lbs. per square inch of air in two minutes.

x Since writing the foregoing, Charging Group No. 647 has been superseded by an improved version called the "Vitiver".

The pump has six outlets enabling six "Favori-Colibri" to be charged simultaneously with liquid up to 170 lbs. per square inch in three minutes. The six outlets are arranged in two groups of three. By means of an instantaneous valve all six, or either three, can be closed as desired. Each charge hose is fitted with a tap and instantaneous bayonet joint, which prevent surplus liquid being wasted between the pump and the sprayers. A regulator and safety valve (adjusted before despatch to give a working pressure of 170 lbs. per square inch) can be varied to give lower working pressures, if desired, and ensures the return to the tank of any surplus or unused liquid, for example when fewer than six "Favori-Colibri" sprayers are being charged at once. A readily accessible clutch throws the pump out of gear when it is only necessary for the air compressor to be in use.

The unit is supplied with a 9' 6" length of suction hose fitted with a strainer and a 9' 6" length of return hose. The overall dimensions are:

|        |     |
|--------|-----|
| Length | 38" |
| Width  | 24" |
| Height | 25" |

Several modifications were made to the standard pipelines to meet our particular requirements. On the suction side of the pump there are two hose connections. One of these was taken to a 100 mesh line strainer and a wheel valve fitted at the base of the fungicide tank. The other is fitted with a wheel valve and length of hose which can be inserted into a bucket or drum of clean water to facilitate washing of the pump and knapsacks at the end of a day's work. A pressure gauge has also been fitted to the air compressor which facilitates the topping up and checking of the air pressure in knapsacks not fitted with pressure gauges.

Petrol consumption is approximately half a gallon per 6 hour working day, when the machine is serving 12 sprayers. Since the machine was introduced the spraying labourers have covered approximately 3 acres each, per day.

55/10 PRESSURE REGULATION OF KNAPSACK SPRAYERS. (Reproduced Whole).

J. LANDRETH. (1954). Tea Quarterly (Ceylon), vol. 25, pt. 3, p. 62.

In the Tea Quarterly vol. 23, part 3 of 1952, the writer made a note on an improvement to pneumatic knapsack sprayers, namely regulation

of the outlet pressures. Since that time several manufacturers of spraying machinery have incorporated pressure regulating devices as a normal fitting on their knapsack sprayers. It might be mentioned also that the attachment of such fittings is recommended by the World Health Organization. Although pressure regulating valves are by no means new and have been used for many years for accurate reduction in the pressure of compressed air, gas, liquid and steam etc., I think we can claim to be the first to have adapted these to suit knapsack sprayers. In low volume knapsack spraying constant output pressures are most desirable, especially as the spray characteristics of a given nozzle alter with any variation in the pressure.

Fig. 1 shows a section drawing of an efficient pressure regulating valve very similar to that fitted on the 'Favori-Colibri' equipment, and the principle of its operation is as follows:-

Assuming liquid to be in the inlet side, Fig 2 shows the valve held in the closed position by spring B. It will be noted also that the valve spindle is clear of the elastic diaphragm.

In Fig. 3 pressure has been applied to the diaphragm by altering the position of the handwheel which compresses spring A and in turn opens the valve and allows liquid to flow into the outlet side and thence to the spray nozzle. On liquid passing through the valve, the pressure gradually increases on the outlet side, compressing spring A through the diaphragm until the reduced pressure to which the valve is adjusted is reached, when the valve closes. As soon as the pressure on the outlet or reduced side begins to drop, spring A begins to open the valve again and the same cycle of operations takes place. Although a valve of the type shown in Fig. 1. can be adjusted to suit any pressure desired within the operating limits of a knapsack, there is no point in adjusting it to a higher pressure than the initial charge of air in the knapsack, as it becomes inoperative at any pressure lower than that to which it is adjusted.

Owing to the drop in pressure in a knapsack as the liquid discharges, regulation of outlet pressure within reasonable limits can only be obtained if the diaphragm in the reducing valve is of adequate area.

This type of valve has proved highly satisfactory and can be substituted for the normal outlet cock on a knapsack sprayer, the liquid supply being cut-off when desired by rotating the handwheel in an anti-clockwise direction. The two nuts fitted to the handwheel spindle are locked in position to give the desired pressure at the nozzle, after which no further adjustment is necessary.

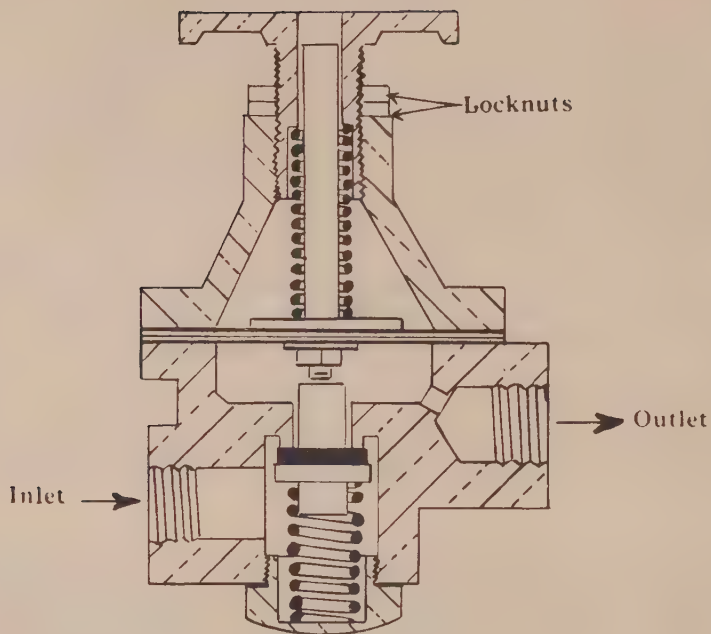


Fig. 1  
Section Through  
Pressure Regulating Valve

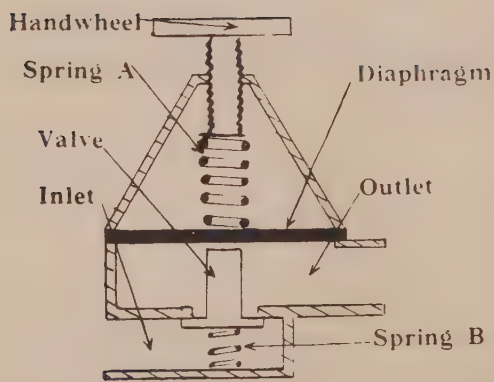


Fig. 2

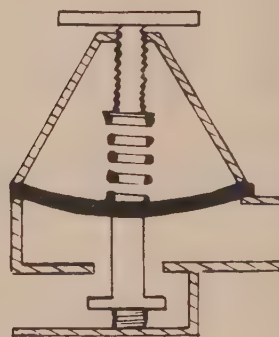


Fig. 3

A 'Favori-Colibri' knapsack charged with air to 40 lb. per sq. inch and then with liquid up to 115 lb. per sq. inch (approximately  $2\frac{1}{2}$  gallons) and fitted with No. OC-02 Boomjet Nozzles discharges in 6 minutes. When fitted with the Cooper Pegler Pressure Regulating Valve adjusted to give a nozzle pressure of 40 lb. per sq. inch, the time taken to discharge the knapsack is approximately 8 minutes. In other words the nozzle output with the regulating valve is  $18\frac{3}{4}$  gallons per hour and without 25 gallons per hour. It is obvious from the foregoing figures that the additional cost of regulators is fully justified.



## SUPPLEMENT I

### EAST AFRICAN INSECTICIDE SUB-COMMITTEE. NOTES ON INSECTICIDAL MACHINERY.

These notes consist of lists of features found desirable in certain kinds of insecticidal machines for use in peasant or plantation agriculture. Rough ground and inexperienced handling make strength and simplicity more important than in Britain. The original notes were drawn up by Mr. T. R. Jones, Research Mechanic, Entomological Section, Uganda Department of Agriculture, and have been amplified by the Insecticide Sub-Committee of the East African Agricultural Specialist Entomological and Insecticide Committee. They are being circulated for guidance and for comment to interested users in East Africa and to certain official bodies and manufacturers in Britain. Work on an increasing range of machines is continuing, and comments and queries would be welcomed by the Senior Entomologist, Kawanda Agricultural Research Station, P.O. Box 265, Kampala, Uganda.

#### Hand Bellows Dusters

1. The bellows system is excellent for very small hand machines but not for anything larger.
2. The new Swaine Concertina Duster, recently invented in Tanganyika, and one of the commercial types are excellent machines worthy of large scale trial.
3. Other types are too fragile or too flimsy.
4. The best bellows dusters will probably prove as efficient as rotary blowers and far cheaper and simpler.

#### Rotary Dust Blowers

The following points are desirable:-

1. A large and comfortable body pad.
2. A cranking speed of about 5 revolutions per minute, or to coincide with steps when walking.
3. A crank radius of not more than 7 inches.
4. A hopper capacity of not less than 8 pints, 12 being better.
5. A handle to enable the operator to hold the applicator steady.
6. A rotating fan housing to allow variable outlet pipe angle.
7. All working parts easily accessible for maintenance.
8. Vertical feed with a large hole, fed slowly, with good agitation.
9. Spade rather than fish-tail spout, to reduce clogging of outlet.
10. Must be capable of working in wet vegetation.
11. Plastic rather than metal outlet tubing.

### Hand Piston Dusters

The piston pumping action is tiring if done for long. Piston pumps are therefore more suited for gardeners than farmers. The following points are desirable:-

1. A good output.
2. A large diameter pump, the barrel strong enough not to be easily dented.
3. A large container, not less than 20 fluid ounces.
4. Strong junction between container and barrel.
5. The minimum number of gasket joints.
6. Gaskets of lasting material.
7. Gaskets bonderised, not loose.
8. No pressed steel screw threads.
9. Piston removable.
10. Must not clog if dust contains lumps, whether pointed up or down.
11. Handles solid, not wire loop.
12. Handles to have adequate clearance, so as not to knock fingers against end of barrel when pumping.

### Hand Atomisers

There is a need for both the better class brass machines and the very cheap tin types.

1. For most agricultural uses a continuous action is desirable.
2. Nozzle must not spit, stream or dribble, whether pointed diagonally up or down.
3. A large diameter pump, the barrel strong enough not to be easily dented.
4. A large container, not less than 20 fluid ounces.
5. Strong junction between container and barrel.
6. No pressed steel screw threads.
7. Piston removable.
8. Handles solid, not wire loop.
9. Handles to have adequate clearance, so as not to knock fingers against end of barrel when pumping.
- 10 Siphon tube to reach into corner to ensure emptying of container, from cover for sprayers for use on ground crops, hind corner for tree crops.

### Hand Syringe Sprayers

1. Glands to be large enough to permit accommodation of wear over a period of time.
2. A pistol grip handle behind and some type of handle not too tiring to hold over long periods in front.

3. An incorporated pressure chamber is often desirable.
4. Adequate filtering.
5. Improved cup washers or some alternative and superior type of washer.
6. Silver, not lead, soldering.
7. Avoid too fine threading if possible.
8. Handles to have adequate clearance, so as not to knock fingers against end of barrel when pumping.
9. Nozzles not to dribble; spring-loaded nozzles worth considering for this purpose.

### Stirrup (Bucket) Pumps

This type of sprayers is useful for certain purposes and seldom gives trouble. Some makes are unnecessarily massive and therefore expensive.

### Hydraulic Knapsack Sprayers

1. Shoulder straps to be wide, padded with Sorbo rubber or otherwise made comfortable for use by thinly clad men in a hot climate.
2. Sway of the machine on the body during pumping to be obviated. Crossing the shoulder straps will sometimes do this but makes the body feel constricted and hot.
3. Pressure-retaining chamber desirable if possible without too much increase in price.
4. The least tiring pumping action seems to be an up and down motion of a lever coming over the operator's shoulder, without a long hanging handle at the end.
5. The minimum of projecting, fragile parts; handles and other long projections to be removable for travelling.

### Pneumatic Knapsack Sprayers

1. Both sprayers which do and which do not retain their air pressure have their uses.
2. Lances working with a pressure valve are more convenient than those with a tap. For much agricultural spraying it is best for the valve to be closed when gripped. The opposite type, opened by gripping, is useful for intermittent spraying.
3. Lances with a pressure valve should have a clip to grip the handle and keep it closed, or open, as the case may be, so as to free the hand needed for other purposes.
4. The pressure gauge should have its outer sheath extended to contract the surface of the canister, in order to prevent it being used as a handle.
5. No pressure gauge to project over the edge of the canister.

6. No suction or discharge pipes to project beyond the sheath at the base of the container further than is necessary to accommodate the valve.

7. Discharge pipe main valve to be of the screw type.

8. Piston shaft, when built in, to be secured rigidly in its lowest position by some form of clamp.

9. A handle permanently fitted to the upper portion of the canister for convenient carrying, in order to save the pressure valve from being used for this purpose.

10. Valve boxes and pipes fitted thereto to be silver soldered.

11. Shrader valves to be fitted for rapid charging when air compressor is available.

12. Comfortable strap or shoulder clip fittings to the body.

13. A good type of valve e.g. ball valve, at bottom of pump.

14. Constant pressure valve.

#### Tractor-mounted Boom Sprayers operated by Power Take-off

1. Controls to be accessible from the driver's seat.

2. Roller vane pumps may be better than gear pumps.

3. Horizontal booms to close vertically.

4. Booms and drop-legs to swing freely on striking obstructions.

5. Base of tank to be sloping to facilitate complete extraction.

6. If mounted on hydraulic lift, there should be support brackets to remove the load from the lift when in operating position.

7. Hi-capper filters.

8. Large basket strainers of rigid construction.

9. Pump capacity to be more than adequate.

10. Booms not more than of 18-20 feet span for peasant farms.

11. Tank with top opening wide enough to permit easy cleaning out.

#### Generalities

1. Rubber to be replaced by substitutes whenever possible.

2. Nozzles to be simple, consisting of as few parts as possible.

3. Nozzle swirl plates to have handle and thread for screwing into nozzle, to prevent falling out and loss when cleaning in field.

SUPPLEMENT II

TABLE OF PROPOSED TOLERANCES. (Abridged Version).  
FOOD AND DRUG ADMINISTRATION, U.S.A. (See News Item vii).

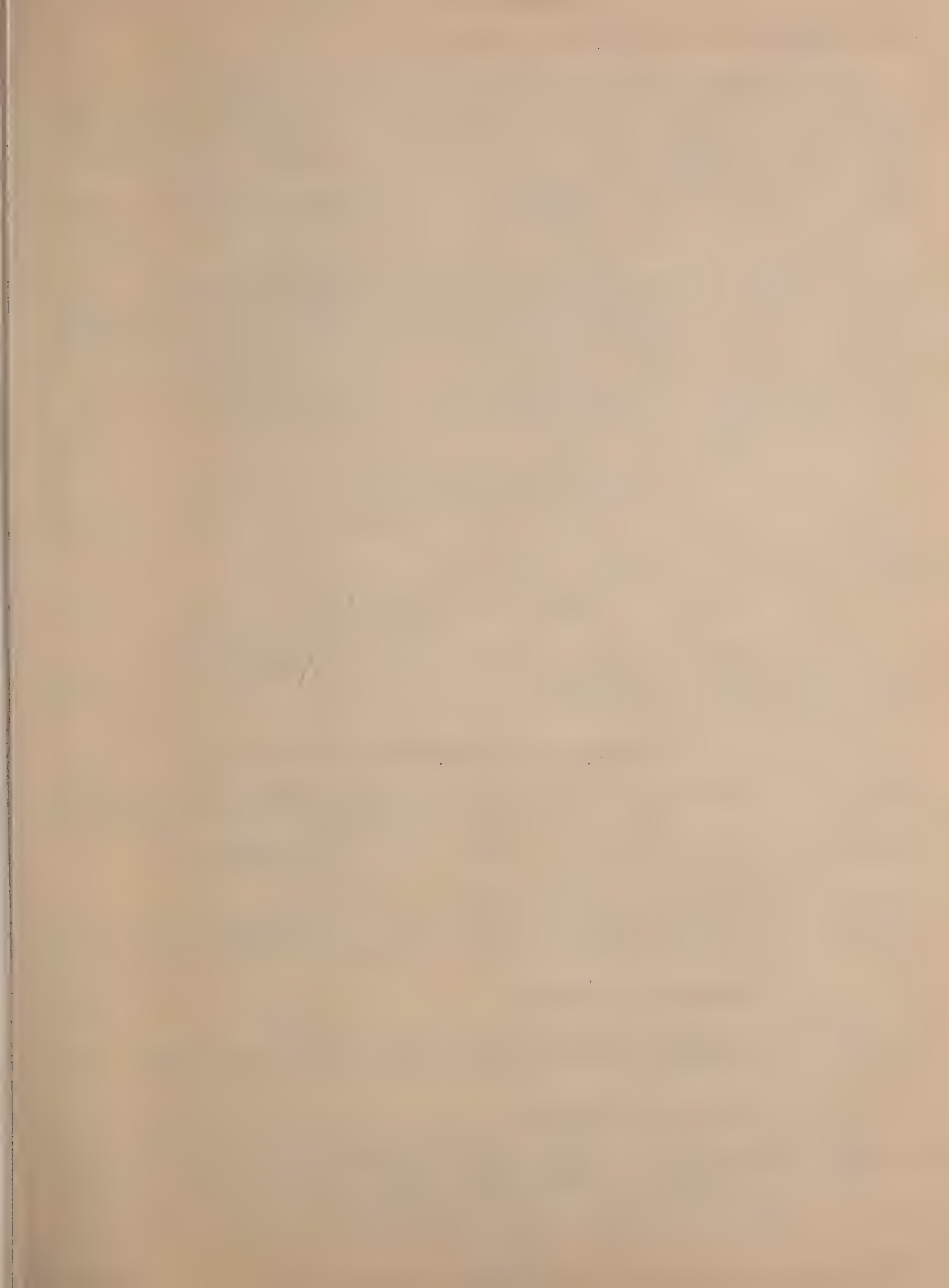
The proposed tolerances apply to all types of fruits and vegetables but in this abridged list only a selection has been made in favour of tropical and sub-tropical produce.

| Pesticide                                                   | Tolerance<br>in p.p.m.                     | Fruits and vegetables to<br>which tolerance applies                                                                                                                     |
|-------------------------------------------------------------|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Aldrin                                                      | 0.1                                        | Sweet potatoes                                                                                                                                                          |
| Benzene<br>hexachloride                                     | 5                                          | Apples, pears, quinces,<br>avocados, citrus fruits,<br>guavas, mangoes, pineapples,<br>eggplants.                                                                       |
| Calcium arsenate                                            | 3.5 of combined<br>$\text{As}_2\text{O}_3$ | Eggplants, melons, peppers,<br>pumpkins, squash                                                                                                                         |
| DDT                                                         | 7                                          | Apples, pears, quinces,<br>avocados, citrus fruits,<br>guavas, mangoes, papayas,<br>nectarines, pineapples,<br>eggplants, melons, peanuts,<br>peppers, pumpkins, squash |
| Chlordane or<br>heptachlor                                  | 0.1                                        | Potatoes                                                                                                                                                                |
| 2, 4-D acid                                                 | 5                                          | Apples, pears, quinces,<br>citrus fruits.                                                                                                                               |
| Dicyclohexyl-<br>amine salt of<br>dinitro-O-<br>hexylphenol | 1                                          | Apples, pears, quinces,<br>apricots, peaches,<br>nectarines.                                                                                                            |
| Dieldrin                                                    | 0.1                                        | Apples, pears, quinces,<br>apricots, peaches, nectarines                                                                                                                |
| EPN                                                         | 3                                          | Apples, pears, quinces,<br>apricots, citrus fruits,<br>peaches, nectarines,<br>pineapples.                                                                              |

| Pesticide                    | Tolerance<br>in p.p.m.                  | Fruits and vegetables to<br>which tolerance applies                                                                                                                                       |
|------------------------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Perbam                       | 7                                       | Apples, pears, quinces,<br>apricots, guavas, dates,<br>mangoes, papayas, peaches,<br>nectarines, eggplants,<br>melons, peanuts, peppers,<br>pumpkins, squash.                             |
| Fluorine<br>compounds        | 7 of<br>combined fluorine               | Apples, pears, quinces,<br>apricots, citrus fruits,<br>peaches, nectarines, egg-<br>plants, melons, peanuts,<br>pumpkins, squash.                                                         |
| 2-Heptadecyl<br>glyoxalidine | 5                                       | Apples, pears, quinces                                                                                                                                                                    |
| Lead arsenate                | 7 of<br>combined lead                   | Apples, pears, quinces,<br>apricots, peaches,<br>nectarines, eggplants,<br>peppers, avocados.                                                                                             |
| Lead<br>arsenate             | 1.0 of<br>combined lead                 | Citrus fruits (grapefruits,<br>lemons, oranges, tangerines).                                                                                                                              |
| Methoxychlor                 | 14                                      | Apples, pears, quinces,<br>apricots, peaches,<br>nectarines, pineapples,<br>eggplants, melons, peppers,<br>pumpkins, squash.                                                              |
| Naphthalene<br>acetic acid   | 1                                       | Apples                                                                                                                                                                                    |
| Parathion                    | 1                                       | Apples, pears, quinces,<br>apricots, avocados,<br>citrus fruits, dates, figs,<br>guavas, mangoes, peaches,<br>nectarines, pineapples,<br>eggplants, melons, peppers,<br>pumpkins, squash. |
| Phenothiazine                | 7                                       | Apples                                                                                                                                                                                    |
| Tartar<br>emetic             | 3.5 of<br>combined antimony<br>trioxide | Citrus fruits, grapes.                                                                                                                                                                    |

| Pesticide | Tolerance<br>in p.p.m. | Fruits and vegetables to<br>which tolerance applies                                                           |
|-----------|------------------------|---------------------------------------------------------------------------------------------------------------|
| TDE(DDD)  | 7                      | Apples, pears, quinces,<br>apricots, citrus fruits,<br>peaches, nectarines,<br>eggplants, peppers.            |
| Toxaphene | 7                      | Apples, pears, quinces,<br>apricots, citrus fruits,<br>peaches, nectarines,<br>eggplants.                     |
| Zincb     | 7                      | Apples, pears, quinces,<br>peaches, nectarines,<br>eggplants, melons, peppers,<br>peanuts, pumpkins, squash.  |
| Ziram     | 7                      | Apples, pears, quinces,<br>apricots, nectarines,<br>peaches, eggplants, melons,<br>peppers, pumpkins, squash. |





(xiii) NATIONAL CROP PROTECTION CONFERENCE

The Pesticides Group of the Society of Chemical Industry in collaboration with the Association of British Insecticide Manufacturers, the British Agricultural Contractors' Association, the National Association of Corn and Agricultural Merchants and the National Farmers Union, has organised a conference on the practical aspects of the use of insecticides and fungicides in agriculture and horticulture, to be held in Eastbourne on the 31st October and 1st, 2nd and 3rd November, 1955.

Some twenty-five papers each of about fifteen minutes duration will be presented and time will be allowed for discussion of the various topics. Although organised on a national basis and therefore primarily concerned with the control of pests and diseases of crops in the United Kingdom, there will undoubtedly be much to interest the visitor from overseas. Colonial officers wishing to attend the meeting are invited to write for further details to the Conference Secretary,

G. L. Baldit, Esq., B.Sc.,  
c/o Plant Protection Limited,  
Yalding, Kent, England.

The provisional programme is as follows:-

MONDAY, 31st OCTOBER 1955.

Delegates assemble in their Hotels during afternoon.

6.00 - 7.15 Chairman's Reception.

8.45 - 10.00 Film Show.

TUESDAY, 1st NOVEMBER 1955.

- 9.30 a.m. 1) Welcome by the Mayor of Eastbourne and Mr. Julian Leonard.  
(Pres. of S.C.I.)
- 10.00 a.m. 2) General Survey of crop protection developments in the last 15 years.
- 11.15 a.m. 3) General Survey of eelworm problems.
- 11.40 a.m. 4) General Survey of soil pests.
- 12.05 p.m. 5) General Survey of foliage diseases in arable crops.

Agricultural Problems I

- 2.30 p.m. 6) Economics of potato blight control.
- 3.05 p.m. 7) Virus problems in sugar beet.

Agricultural Problems II

- 4.15 p.m. 8) Control of pests in arable crops.
- 9) Control of pests in seed crops.

8.30 p.m. Civic Reception by Mayor of Eastbourne.

Application Problems I

- 9.15 a.m. 10) Application of materials to control pests and diseases of pea crops.  
9.50 a.m. 11) Advantages of high v. low volume spraying.

Application Problems II & Hazards

- 11.15 a.m. 12) Application aspects of aphid control in sugar beet, brassicas, and related crops.  
11.45 a.m. 13) Application hazards with particular reference to the organo phosphorus compounds.  
12.5 p.m. 14) The residues problem.

Seed Dressings

- 2.30 p.m. 15) New developments in the application of gamma BHC/Org.Hg. seed dressings.  
2.55 p.m. 16) Dieldrin seed dressings.  
4.15 p.m. 17) The taint problem.  
4.50 p.m. 18) Crop Protection Products Approval Scheme.

THURSDAY, 3rd November 1955

Glasshouse Problems

- 9.15 a.m. 19) The control of fungi under glass.  
9.50 a.m. 20) The control of insects under glass.

Horticultural Problems I

- 11.15 a.m. 21) Control of red spider on fruit.  
11.50 a.m.) 22) Control of other fruit pests.

Horticultural Problems II

- 2.00 p.m. 23) New techniques for the control of pests on hops.  
2.40 p.m. 24) Recent advances in scab control  
3.10 p.m. 25) New chemicals in the horticultural field.

3.45 p.m. Closing remarks by Dr. R. A. E. Galley.

(xiv) AGRICULTURAL INSECTICIDE RESEARCH IN EAST AFRICA

The proceedings of the Second Meeting (Nov. 1-5, 1954) of the Insecticide Sub-Committee of the East African Agricultural Specialist Entomology and Insecticide Committee were briefly reported in the last issue (No. 1) of the PESTICIDES ABSTRACTS AND NEWS SUMMARY. Summary reports of insecticide research in progress in East Africa were presented at this meeting and the main points are given overleaf.

Coffee Research Station, Ruiru, Kenya. (Mr. R. W. Rayner and Mr. D. MacCrae).

(a) In general persistent insecticides were discouraged owing to the danger of upsetting the balance of nature in the complex fauna of coffee. Exceptions were made for local emergencies such as Thrips foci or small Antestiopsis outbreaks and for stem treatments against ants tending mealybugs and against White Borer.

(b) Dusts had certain advantages over sprays on coffee, one being that dusts were less persistent.

(c) The organo-phosphorus compounds were discouraged because of the human hazards involved in their application.

(d) The research programme included work on soil pests e.g. cutworms and chafer grubs.

(e) Fungicide research (Mr. R. W. Rayner). Trials of spraying equipment might be of interest to the entomologists. For plantation work, knapsack sprayers were being ousted by larger power driven equipment. Airblast, low-volume machines such as the "Agro" and "Autoblast" were giving promise of being better than high volume sprayers, as they turned the leaves and helped the spray to penetrate the foliage well.

Other Insecticide Work in Kenya.

In the absence of Dr. Le Pelley, the following projects were extracted from his sectional programme, which had been presented to the June meeting of the Specialist Committee.

- (a) Coreid bug of coconuts: experiments in direct control of ants with dieldrin or chlordane.
- (b) Cotton: tests of methods already proved elsewhere.
- (c) Stored products.
- (d) Soil pests of cereals: Schizonycha and Heteronychus.
- (e) Stalk borers in sorghum, with DDT, endrin and isodrin.
- (f) Bruchidae on beans: field spraying and dusting trials with DDT.

Tanganyika Department of Agriculture.

The following points were mainly taken from the programme produced by Mr. Swaine for the June meeting.

(a) White Borer of Coffee, Anthores leuconotus: control with persistent insecticides applied to the trunks (Mr. Tapley, Lyamungu).

(b) Sugar Cane White Grub: trials of aldrin dust in the soil.

(c) Pests of seed beans: practical trials of low volume DDT sprays (it was understood that this work had come to an end).

(d) Coffee Berry Borer, Stephanoderes hampei in Bukola: trials of control with lindane.

(e) Sisal Weevil, Scyphophorus acupunctatus, at the Sisal Research Station; control with dieldrin.

(f) Pests of cashew; problems of application of insecticides.

(g) Field scale trails of the Swaine hand duster on Ootheca and Busseola.

(h) Stored products.

#### Overseas Food Corporation, Nachingwea.

Dusting experiments against pests of cotton especially bollworms and stainers.

#### Coconut Pest Research, Zanzibar.

Coreid bug: development of contact and residual insecticides and special machines for applying them in collaboration with Dr. Kearns, Long Ashton, U.K.

#### Department of Agriculture, Uganda.

The Entomological section was deliberately restricting its trials of insecticides to safe materials readily available to the East African public.

(a) Chemical control of Lygus vosseleri on cotton.

(b) General problems of the application of insecticides to peasant agriculture, with emphasis on the machinery aspect.

(c) In addition some attention was being given to chemical control of pests in coffee plantations.

#### Empire Cotton Growing Corporation.

At Namulonge in Uganda, Mr. Coaker was using insecticides as research tools rather than investigating their actual use. At Ilonga in Tanganyika, Mr. Valentine was making biological observations on the field experiments of the Colonial Agricultural Research Unit.

#### Colonial Insecticide Research Units.

Reports were also received from the Colonial Insecticide Research Units at Ilonga and Arusha.

COTTON RESEARCH STATION NAMULONGE, UGANDA

On the Communal Experiment single row plots were laid down for spraying over various periods to estimate the losses of crop caused by insects. One formulation of DDT paste was used, applied as a 0.2% spray to run-off at 7 day intervals. The main spray-periods were (a) August-September, (b) October-November, (c) August-November inclusive, (g) September to November. These periods had been decided on to protect the cotton separately from (a) the bulk of Lygus attack; and (b) the bulk of bollworm; treatment (c) was complete protection, and (g) permitted the early attack to go unchecked. The Lygus population, and consequent leaf damage, increased during September-November, the peaks varying in the three localities. The populations of bollworms (see below) were so small that the main effects of spraying resulted from control of Lygus over different periods of the season.

On the early sowing, the final yields of seed cotton showed that in none of the three areas did complete protection (17 weekly applications of DDT spray) give a significant increase in yield. This treatment however, significantly reduced the Lygus leaf-damage index to 36-57% of the controls, the bollworm attack measured by flared squares to 2-8% of the controls. In only one of the three areas was a significant increase in yield obtained, and this (at Nalumuli) resulted from the September-November spraying.

The predominant result of this degree of protection was an earlier crop. Highly significant differences in yield were apparent at the 7th picking (out of a total of 13), but by the end of the season the favourable rains had enabled the unsprayed plots to catch up. There were significant negative correlations between yield at the 7th pick, and both leaf-damage index and bollworm index. Because of a strong interaction between these two measures of insect attack, it is not possible to estimate their separate effects on yield. Bollworm populations were, however, too small to be responsible per se for the variations in earliness.

On the later sown cotton (August 10), the spray treatments gave the following results:-

(1) In only one of the three localities (Nalumuli) did continuous protection (mid Sept.-Mid Dec.) give a significant increase in yield; in this instance an increase of 512 lb. per acre of seed cotton over a control yield of 620 lb. or 82%. In all localities, however, significant reductions were effected in Lygus leaf damage and bollworm damage.

(2) In the other two localities (Namulonge and Kirimantungo) significant increases in yield were obtained by late spraying in November when bulk of the Lygus attack developed on the late sowing.

(3) Spraying again gave an earlier crop, but unprotected plants did not catch up.

(4) In contrast to the early sowing, there was a significant negative correlation ( $r^2 = 0.71$ ) between Lygus leaf-damage index and final yield.

For the present season therefore the following conclusions emerge. Only on late-sown cotton was Lygus damage causing appreciable loss of yield. This may have been excessive on the Communal Experiment where early and late sowings were adjacent, and breeding occurred throughout the season. The main effect of Lygus on the earlier sown cotton was to delay the cropping. The best treatments, however, only reduced the Lygus leaf damage index to 36% of that on the controls. With complete protection the results might have been different. Steps are being taken to improve the degree of control, but it is worth noting here that in all the experiments conducted, this is the best reduction in attack as measured by leaf damage that has been so far achieved.

The results obtained in this first season of the Communal Experiment have shown from an entomological viewpoint the absolute necessity of continuing such experiments over a number of years, in order to cover the variations of both climatic conditions and levels of insect attack. Already, within the limits of a research station the marked effect of locality is apparent: in this instance causing differences in timing of the insect attack, and rate of maturation of the crop - two factors which could have a great influence on the damaging capacity of an insect such as Lygus.

#### WEST INDIES

Trials were carried out in all three islands. In Montserrat special attention was given to pink bollworm but no useful results were obtained as infestation throughout the season was very low. In Antigua the main pests in the trial were Nezara viridula, some Heliothis sp. and some aphids. The treatments and results of the trial are tabulated - Fosferno 20 was added to the DDT treatments to offset any aphid build-up and a treatment with Fosferno alone was included. The control treatment consisted of the application of lead arsenate should it be required to meet leafworm attack.

The layout of the trial consisted of 4 randomised blocks, the plot size being 1/27 acre. Planting was done on 10th September at a spacing of 4 ft. x 2 ft. with 2 plants per hole. Insecticide application started on 8th December and continued weekly until mid February.

Endrin and the two DDT plus Fosferno 20 treatments gave large and significant increases over the control with Fosferno alone slightly better than the control. These yield increases were due in the main to control of Nezara. The DDT treatments gave indications of Heliothis control but generally the infestation by this pest was not high while pink bollworm was negligible.

# Insecticide Trial: Antigua

| Treatment              | Rate per acre   | Yield Seed Cotton |              | Sheds % of Control |              |           |
|------------------------|-----------------|-------------------|--------------|--------------------|--------------|-----------|
|                        |                 | per acre lb.      | As % Control | Total              | Sucking bugs | Heliothis |
| 1. Control             |                 | 680               | 100          | 100                | 100          | 100       |
| 2. 50% DDT Treatment 5 | 4 lb.           | 1,136             | 167          | 84                 | 20           | 57        |
| 3. DDT Emulsion 5      | 2 lb. Technical | 1,050             | 154          | 74                 | 12           | 34        |
| 4. Endrin              | 0.5 lb.         | 1,086             | 160          | 56                 | 14           | 86        |
| 5. Fosferno 20         | 48 ccs.         | 759               | 112          | 93                 | 77           | 83        |
| S.E. Difference        |                 | +67.1             | +9.9         | +8.8               | +16.7        | +23.0     |
| C.D. 5%                |                 | 206.6             | 30.4         | 27.2               | 51.5         | N.S.      |

In a somewhat similar trial last season the DDT treatments did not have Fosferno 20 added and the build-up of aphids was considerable, with the result that Endrin was the only treatment to outyield the control significantly. In the present trial aphids did not build up to any considerable extent where Fosferno was added to the DDT though some increase did occur by mid March and these treatments lost leaf earlier than the Endrin plots.

The main conclusions are that DDT and Endrin both control sucking bugs but to prevent aphids build-up the addition of Fosferno to the DDT is desirable.

The control of Heliothis appears more promising with DDT and some indications of the value of DDT in pink bollworm control have been noted in earlier trials.

In St. Vincent a trial was laid down with 6 treatments in 4 randomised blocks, the plot size being 1/22 acre. The treatments included Toxaphene both as a spray and as a dust; DDT wettable powder; Agroside Cotton Dust; BHC wettable powder and a control treatment of lead arsenate when required for leafworm protection.

The yield over the trial averaged 1,366 lb. seed cotton per acre, easily the highest on the Station, and differences were small and non-significant. The only point of note was the rather low yield from the BHC wettable powder treatment. In this treatment the plants had a shorter cropping season and the question of phytotoxicity needs attention.

World Health Organization, Tech.Rep.Ser. (1954), 90.

Price 1/9d. from H.M.S.O., P.O. Box 569, London, S.E.1.

One of the most difficult problems in the study of bilharziasis is the identification of the snail vectors of the disease. There is much confusion regarding the status of many species of snail vectors and a need to establish criteria to enable the field worker to make a primary identification and the malacologist to reach a definite identification and classification. The molluscan family Planorbidae, to which the snail vectors of Schistosoma belong, is large, and numbers of species have evolved, with representatives present throughout the world. Most of these species lack easily recognizable characters or ornamentation that would aid in identification. In addition, many of the descriptions of species have been based only on shell characters, no information concerning the anatomy of the animal being given.

A recent WHO technical report attempts to throw light on this problem. The work of a special WHO study-group, the report sets for principles of classification and criteria for the identification of snail vectors of bilharziasis, particularly for African Planorbidae; specifies the data which should accompany all snail collections sent for identification; and describes acceptable methods for the preservation of vector molluscs. It contains a tentative list of various African species of Biomphalaria which may be helpful to field workers, although the classification given is not to be considered as final.

The report calls attention to the fact that much research remains to be done in medical and veterinary malacology. Most important are the contributions of field workers, who should send material to malacologists for study. Assistance in the compilation of a file of the original descriptions of molluscs which are intermediate hosts of bilharziasis, and of their close relatives, is requested, priority to be accorded to study of Planorbidae (Biomphalaria and Bulinus) from Africa, the Mediterranean region, and South America, in that order. The descriptions should be accompanied by photographs of the type species.

Information on seasonal infection of snail hosts is also sought. Other subjects on which research is essential are outlined in the report. It is emphasized that further advances in the study of snail vectors will require the collaboration of malacologists, parasitologists, ecologists, and limnologists, and close co-operation between field workers, national research institutes, and international reference institutes.

(xvii) CHANGES IN THE PROPOSED AMERICAN PESTICIDE TOLERANCES

In P.A.N.S. No. 1 some details were given of the proposed schedule of tolerances for pesticide residues issued by the Food and Drug Administration in the U.S.A., and it was emphasized that the schedule of tolerances was tentative and liable to be changed.

As a result, eleven companies, who were parties to the 1950 hearings, filed exceptions to the tolerances issued in the tentative order of October 20th 1954, and official changes to the order have recently been issued. Of these changes, the most significant is one permitting a higher tolerance in nicotine compounds, than was originally proposed. The F.D.A. has set a nicotine tolerance of two parts per million instead of the proposed zero tolerance which appeared in the tentative schedule.

Other major changes are 1) An increase in the chlordane tolerance from 0.1 p.p.m. to 0.3 p.p.m.; 2) A tolerance of 1.0 p.p.m. was set for dinitro-O-cyclohexyl phenol, which was inadvertently omitted from the tentative order and 3) The method of calculating tolerances for mixtures of residues of pesticides with related pharmacological effects was re-stated and clarified.

Some of the changes affecting the Proposed Tolerances are given below.

AMENDMENTS TO TABLE OF PROPOSED TOLERANCES (Abridged Version)  
FOOD AND DRUG ADMINISTRATION, U.S.A.

| Pesticide                                                       | Tolerance<br>in p.p.m.                               | Fruits and vegetables to which<br>tolerance applies                                                                                                                                             |
|-----------------------------------------------------------------|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Benzene<br>hexachloride                                         | 5                                                    | Additional produce: melons,<br>pumpkins, squash.                                                                                                                                                |
| Calcium<br>arsenate                                             | 3.5 of<br>combined<br>As <sub>2</sub> O <sub>3</sub> | Additional produce: Summer squash,<br>rutabagas.                                                                                                                                                |
| DDT                                                             | 7                                                    | Additional produce: summer squash,<br>escarole, fresh prunes.                                                                                                                                   |
| Chlordane                                                       | 0.3                                                  | Apples, pears, quinces, apricots,<br>citrus fruits, grapes, papayas,<br>peaches, nectarines, pine-apples,<br>corn, eggplants, melons, peanuts,<br>peppers, rutabagas, squash, summer<br>squash. |
| Heptachlor                                                      | 0.1                                                  | Potatoes.                                                                                                                                                                                       |
| Dicyclohexyl-amine<br>salt of dinitro-O-<br>cyclo-hexyl phenol. | 1                                                    | Apples, pears, quinces, apricots,<br>peaches, nectarines.                                                                                                                                       |
| Dinitro-O-cyclohexyl-<br>phenol.                                | 1                                                    | Citrus fruits.                                                                                                                                                                                  |
| EPN                                                             | 3                                                    | Additional produce: fresh prunes,<br>rutabagas.                                                                                                                                                 |

| Pesticide                            | Tolerance<br>in p.p.m.       | Fruits and vegetables to which<br>tolerance applies                                                                                                                      |
|--------------------------------------|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ferbar                               | 7                            | Additional produce: fresh prunes,<br>corn, summer squash, rutabagas.                                                                                                     |
| Fluorine<br>compounds                | 7 of<br>combined<br>fluorine | Additional produce: fresh prunes,<br>summer squash, rutabagas.                                                                                                           |
| Lead arsenate                        | 7 of<br>combined<br>lead     | Additional produce: fresh prunes,<br>avocados.                                                                                                                           |
| Methoxychlor                         | 14                           | Additional produce: fresh prunes,<br>rutabagas, summer squash.                                                                                                           |
| Nicotine-<br>containing<br>compounds | 2 of<br>nicotine             | Apples, pears, quinces, apricots,<br>avocados, citrus fruits, peaches,<br>nectarines, fresh prunes, corn,<br>eggplants, melons, peppers, pumpkins,<br>squash, rutabagas. |
| Parathion                            | 1                            | Additional produce: fresh prunes,<br>rutabagas, summer squash, peanuts.                                                                                                  |

(xviii) THE U.S. CHEMICAL-BIOLOGICAL COORDINATION CENTER. OFFER OF  
COLLABORATION WITH ORGANIZATIONS IN THE COMMONWEALTH.

British Commonwealth Scientific Office (North America),  
Report No. 1005. Dec. 1954.

The Chemical-Biological Coordination Center of the National Research Council has been set up in Washington to provide accessible records of data relating chemical constitution to biological activity. The information, culled from both published and unpublished data, is recorded on data sheets and also on punched cards which can be mechanically sorted. The coding systems adopted enable all the recorded data in almost any defined field to be separated from the mass and a list of references prepared for the enquirer.

The facilities of the Center are available to all bona fide enquirers of the U.S.A.: it is now desired to expand the contracts to include workers in the British Commonwealth. The Center is prepared to accept enquiries from organizations in the Commonwealth: it will also be pleased to receive suitable material for inclusion in its records, particularly unpublished data or data published in relatively inaccessible journals.

The field covered is wide and includes human and mammalian effects, data on insecticides, fungicides, mollusc poisons, selective weedkillers and so on. The Center is in fact potentially interested in any data relating chemical constitution and biological activity. It now has

on record some 150,000 biological test results with some 50,000 identified chemical compounds. The test results are increasing at the rate of about 2,500 per month.

Examples of the types of question which are suitable for answering from the Center's files are:

- (a) Does adiphenine have local anaesthetic activity?
- (b) What are the biological actions of, or, what biological tests have been performed with, 2, 6-diaminopyridine?
- (c) What derivatives of ethylenediamine have anti-spasmodic activity?
- (d) What are the biological actions of compounds containing a benzene ring with one or more chlorine atoms attached and having an LD<sub>50</sub> of  $> 50$  mg/kg for mammals and an LD<sub>50</sub> of  $< 5$  mg/kg for insects?

The activities of the Center include a screening programme in which it collaborates with a number of U.S. Government agencies. The Center is informed by numerous other organizations of new chemical entities synthesized or isolated. Each month a list of about 100 of these is circulated to the collaborating agencies who choose those which they would wish to receive for test. Samples of the new compounds are then provided through the Center, tested on organisms and the results included in the records of the Center. The Center is glad to receive offers of further new materials: on past experience these are likely to be requested for screening tests on several types of organism by more than one of the collaborating agencies.

Further details are given in a brochure entitled: "The Chemical-Biological Coordination Center of the National Research Council", September, 1954, which is available on request from:

The Chemical-Biological Coordination Center.  
National Research Council,  
2101 Constitution Avenue,  
Washington 25, D.C.,  
U.S.A.

Any organization wishing to collaborate is recommended to get in touch direct with the Chemical-Biological Coordination Center.

(xix) THE AGRICULTURE (POISONOUS SUBSTANCES) REGULATIONS, 1955, STATUTORY INSTRUMENTS 1955 No. 632. (UNITED KINGDOM).

These Regulations revoke the Agriculture (Poisonous Substances) Regulations, 1954 (S.I. 1954/828), and re-enact them with amendments.

The principal innovations are:-

- (i) a new organo-phosphorus compound\* is added to the list of poisonous substances to which the former Regulations applied, but protective clothing is only required to be worn when handling it in its concentrated form; and
- (ii) The Regulations define a new process known as "soil-application" (in which the substances specified in the Regulations, instead of being sprayed directly on to plants, are applied to the soil for absorption by the roots of plants), and prescribe the protective clothing to be worn when this process is adopted.

\*Any mixture of 2-ethylthioethyl dimethyl phosphorothionate and S-(2-ethylthioethyl) dimethyl phosphorothiolate, sometimes known as meta-Systox.

(xx) TECHNICAL BULLETINS

The following technical bulletins and reports have been received.

1. A Summary of the Results of Capsid Research in the Gold Coast, by D. J. Taylor, (1954). West African Cacao Research Institute, Technical Bulletin No. 1. Price 2/6d.
2. Capsids and Capsid Control in the Belgian Congo, by J. Nicol and D. J. Taylor, (1954) W.A.C.R.I. Technical Bulletin No. 2. Price 1/-.

These bulletins are obtainable from the Crown Agents for Oversea Governments and Administrations, 4, Millbank, London, S.W.1.

3. A Spray Deposit Analyser, by E. S. Trickett and R. J. Courshee, (1953) N.I.A.E. Report No. 27.
4. Preparation and Calibration of Glass Slides for Sampling Sprays, by R. J. Courshee and J. B. Byass, (1953). N.I.A.E. Report No. 32.
5. A Tree Spraying Machine, by R. J. Courshee, F. K. Daynes, and J. B. Byass, (1954). N.I.A.E. Report No. 36.

The last three reports are obtainable from the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire.

55/11. AN INVESTIGATION OF SOME FACTORS CONTROLLING THE EFFICIENCIES OF NON-CRYSTALLIZING INSECTICIDES IN RESIN FILMS.  
PART 1. FILMS CONTAINING UREA-FORMALDEHYDE RESINS PLASTICIZED WITH A CASTOR OIL ALKYD

F. BARLOW and A.B. HADAWAY. Colonial Insecticides Research Unit, Porton.

Experiments are reported in which non-crystallizing insecticide films based on urea-formaldehyde resins have been studied. The use of dieldrin, for instance, which is considerably more toxic than DDT to many insects, may allow the production of films which are insecticidally active, and yet show no surface crystal "bloom". Non-blooming, toxic films may also be produced by the inclusion of compounds such as aldrin or gamma-BHC, which exerts a fumigant as well as a contact action.

The base resin used in these experiments was BE.610, containing 60% of a butylated urea-formaldehyde resin, the plasticizer, BA.502, contained 60% of a castor oil alkyd resin. Mixtures of these two resins containing 75:25, 50:50, and 25:75 ratios of urea-formaldehyde (U-F) to alkyd, were used, employing a solvent mixture composed of 4 volumes of xylene to 1 volume of n-butanol.

Insecticides were added to the resin mixtures, the amount added being based on the total resin solids content of the mixture. To promote hardening of the resins, an accelerator was added, which consisted of 10% sulphuric acid in 90% n-butanol, by weight. This accelerator was used in the proportion of 1 part to 20 parts of resin solution by weight. These solutions were applied with a small brush to glass plates 4.2 by 3.2 inches, as the test surface. The average film weight obtained was 155 mg., equivalent to 1.3 ozs. of the original resin solution per sq.yd. This film weight is equivalent to an insecticide dosage of 84 mg. per sq. foot for a 5% insecticide film.

The treated glass plates were stored horizontally on racks in a room at 25°C, relative humidity was not controlled and varied between 40 and 60%. It was shown that films of resin without insecticide stored together with insecticide containing films under these conditions, did not appreciably absorb insecticide vapour.

For the biological tests, flour beetles (Tribolium castaneum Hbst.) and mosquitoes (Aedes aegypti L.) were used. A test procedure for fumigation effects was evolved after several modifications, and the use of Aedes aegypti for this test was abandoned in favour of Tribolium.

The following technique was adopted:-- Each batch of beetles was transferred from its holding tube into a clean glass dish 6.7 cms. in diameter and 1.5 cms. deep. A coated test plate was inverted and placed

on the ground rim of the dish so that beetles crawling in the bottom were exposed to the vapour from the test plate yet were unable to climb the sides of the dish and make contact with the film. After exposure the beetles were transferred to a glass tube containing a piece of blotting paper folded several times.

Mortality counts were made 5 days after the exposure. This method gave repeatable results with good replication.

TABLE I

Tribolium castaneum exposed to the vapour from 50:50 U-F; alkyd resin films containing 5 per cent. aldrin. Three replicates, approximately 50 beetles each.

| <u>Wt. of film</u><br><u>in mgs</u> | <u>Age of</u><br><u>film</u> | <u>Mean percentage kill after exposure</u><br><u>of.....hrs.</u> |          |          |           |
|-------------------------------------|------------------------------|------------------------------------------------------------------|----------|----------|-----------|
|                                     |                              | <u>0.5</u>                                                       | <u>1</u> | <u>2</u> | <u>24</u> |
| 104, 106, 108                       | 1 day<br>11 weeks            | 18                                                               | 57       | 93       | 4         |
| 161, 168, 171                       | 1 day<br>11 weeks            | 14                                                               | 57       | 94       | 53        |
| 186, 195, 213                       | 1 day<br>11 weeks            | 21                                                               | 57       | 93       | 74        |

Table I shows the results obtained with films of different thicknesses, from which it can be seen that the rate of diffusion of vapour from a given area of surface initially was independent of the thickness of the film. As the dosage increased, the fumigant action persisted for a longer time.

TABLE II

Tribolium castaneum exposed to the vapour from 50:50: U-F; alkyd resin films containing 5 per cent. aldrin.

| <u>Age of film</u> | <u>Mean percentage kill after exposure of ..... hrs.</u> |          |          |
|--------------------|----------------------------------------------------------|----------|----------|
|                    | <u>1</u>                                                 | <u>2</u> | <u>4</u> |
| 1 day              | 48                                                       | 96       |          |
| 2 days             | 40                                                       | 85       |          |
| 3 days             | -                                                        | 81       |          |
| 8 days             | 16                                                       | 65       | 96       |

Comparative tests with coatings of the same age are a necessity, as is shown in Table II, where the fumigant effect decreases during the first week after application.

A comparison between the fumigant effect and the combined contact and fumigant effect was made with Tribolium merely by inverting the glass dish and treated plate, so that the beetles crawled on the film.

Results of this test are shown in Table III, from which it can be seen that there was a decrease in both "contact" and fumigant toxicity as the films aged.

TABLE III

Tribolium castaneum exposed to films of 50:50: U-F: alkyd resin containing 5 per cent. aldrin.

| <u>Type of exposure</u> | <u>Age of film</u> | Mean percentage kill after exposure of.....hrs. |     |    |    |    |    |
|-------------------------|--------------------|-------------------------------------------------|-----|----|----|----|----|
|                         |                    | 0.25                                            | 0.5 | 1  | 2  | 4  | 8  |
| Fumigation              | 1 day              |                                                 | 10  | 39 | 98 |    |    |
|                         | 2 weeks            |                                                 |     |    | 5  | 40 | 94 |
| 'Contact'               | 1 day              | 30                                              | 71  | 98 |    |    |    |
|                         | 2 weeks            |                                                 |     | 5  | 61 | 88 |    |

Other contact tests were carried out using Aedes aegypti as the test insect, the results being shown in Table IV.

TABLE IV

Aedes aegypti exposed in contact with films of 50:50 U-F: alkyd resin containing 5 per cent. insecticides.

| <u>Insecticide</u> | <u>Age of film</u> | Mean percentage kill after exposure of .....mins. |    |    |    |    |     |    |    |
|--------------------|--------------------|---------------------------------------------------|----|----|----|----|-----|----|----|
|                    |                    | 0.5                                               | 1  | 2  | 4  | 8  | 16  | 32 | 64 |
| DDT                | 1 day              |                                                   |    |    |    |    | 0   | 8  | 28 |
| Aldrin             | 1 day              |                                                   |    | 18 | 65 | 90 |     |    |    |
|                    | 2 weeks            |                                                   |    |    |    | 0  | 44  | 98 |    |
| Gamma-BHC          | 1 day              | 2                                                 | 44 | 85 |    |    |     |    |    |
|                    | 2 weeks            |                                                   |    |    | 48 | 95 | 100 |    |    |
| Dieldrin           | 1 day              |                                                   |    | 2  | 26 | 83 |     |    |    |
|                    | 2 weeks            |                                                   |    |    | 20 | 73 | 100 |    |    |

Under the conditions of the test, the initial kill obtained with films containing aldrin and gamma-BHC resulted from a combined fumigant and contact action, and there was a marked loss in toxicity after only two weeks. High contact toxicity of films containing 5% dieldrin did not change significantly after 2 weeks.

By contrast, non-blooming films containing 5% DDT showed a low order of toxicity.

Lower ratios of U-F resin to alkyd plasticizer increased the evaporation rate, higher ratios decreased it. With a ratio of 75 U-F: 25 alkyd diffusion of the insecticides from the film was completely prevented and, consequently, the film was biologically inactive. The optimum ratio of U-F plasticizer is somewhere between 75:25 and 50:50. These results are shown in Table V.

TABLE V

Tribolium castaneum exposed to the vapour from U-F resin films containing 5 per cent. aldrin.

| Ratio U-F:<br>alkyd resin | Age of<br>film | Mean percentage kill after exposure<br>of.....hrs. |    |    |    |    |
|---------------------------|----------------|----------------------------------------------------|----|----|----|----|
|                           |                | 0.5                                                | 1  | 2  | 4  | 8  |
| 75:25                     | 1 day          | 5                                                  | 10 | 59 |    |    |
|                           | 1 week         |                                                    | 1  | 1  | 2  |    |
|                           | 2 weeks        |                                                    |    |    |    | 6  |
| 50:50                     | 1 day          | 7                                                  | 56 | 94 |    |    |
|                           | 1 week         |                                                    | 22 | 61 | 92 |    |
|                           | 2 weeks        |                                                    | 2  | 14 | 46 |    |
|                           | 4 weeks        |                                                    |    |    | 13 | 57 |
| 25:75                     | 1 day          | 8                                                  | 52 | 94 |    |    |
|                           | 1 week         |                                                    | 23 | 72 | 97 |    |
|                           | 2 weeks        |                                                    | 2  | 7  | 35 |    |
|                           | 4 weeks        |                                                    |    |    | 6  | 10 |

The contact action of dieldrin in U-F: alkyd films was similarly affected by the U-F: alkyd ratio, as can be seen from the results shown in Table VI.

TABLE VI

Aedes aegypti exposed in contact with U-F resin films containing 5 per cent. dieldrin.

| Ratio of U-F<br>alkyd resin | Age of<br>film | Mean percentage kill after exposure<br>of.....mins. |    |    |     |       |
|-----------------------------|----------------|-----------------------------------------------------|----|----|-----|-------|
|                             |                | 2                                                   | 4  | 8  | 16  | 32 64 |
| 75:25                       | 1 day          |                                                     | 0  | 40 | 100 |       |
|                             | 2 weeks        |                                                     |    |    | 0   | 25 78 |
|                             | 5 weeks        |                                                     |    |    |     | 0 8   |
|                             | 14 weeks       |                                                     |    |    |     | 0 7   |
| 50:50                       | 1 day          | 0                                                   | 26 | 80 |     |       |
|                             | 2 weeks        |                                                     | 20 | 74 | 100 |       |
|                             | 5 weeks        |                                                     | 8  | 54 | 98  |       |
|                             | 14 weeks       |                                                     | 10 | 66 | 98  |       |
| 25:75                       | 1 day          | 0                                                   | 23 | 80 |     |       |
|                             | 2 weeks        |                                                     | 8  | 72 | 98  |       |
|                             | 5 weeks        |                                                     | 10 | 60 | 98  |       |
|                             | 14 weeks       |                                                     | 5  | 47 | 93  |       |

This insecticide is relatively non-volatile, so that low ratios of U-F/alkyd could be used to give maximum toxicity without lowering the residual properties.

Dieldrin in 50:50 resin films was sufficiently toxic to give high kills of mosquitoes without any surface crystallization. DDT in similar films was much less effective and obviously needs to be available to the insects as crystals if it is to act efficiently.

The action of ultra violet light on U-F resin films has also been examined and caused a reduction in the diffusion rates of insecticides from the films resulting in diminished fumigant and contact properties.

TABLE VII

Tribolium castaneum exposed to the vapour from 50:50 U-F: alkyd resin films.

| Insecticide  | Exposure time<br>to U.V. light | Mean percentage kill after<br>exposure of.....hrs. |    |    |
|--------------|--------------------------------|----------------------------------------------------|----|----|
|              |                                | 2                                                  | 4  | 6  |
| 5% aldrin    | 0                              | 72                                                 |    |    |
|              | 15 mins.                       | 3                                                  |    |    |
|              | 30 mins.                       | 2                                                  |    |    |
| 5% gamma-BHC | 0                              |                                                    | 35 | 79 |
|              | 15 mins.                       |                                                    | -  | 72 |
|              | 30 mins.                       |                                                    | 28 | 63 |
|              | 60 mins                        |                                                    | 5  | 52 |
|              | 120 mins                       |                                                    | 2  | 19 |

TABLE VIII

Aedes aegypti exposed in contact with 50:50 U-F: alkyd resin films.

| <u>Insecticide</u> | <u>Exposure time<br/>to U.V. light</u> | <u>Mean percentage kill after<br/>exposure of.....mins.</u> |          |
|--------------------|----------------------------------------|-------------------------------------------------------------|----------|
|                    |                                        | <u>2</u>                                                    | <u>8</u> |
| 5% aldrin          | 0                                      |                                                             | 88       |
|                    | 15 mins.                               |                                                             | 10       |
|                    | 30 mins.                               |                                                             | 0        |
| 5% dieldrin        | 0                                      |                                                             | 78       |
|                    | 15 mins.                               |                                                             | 5        |
|                    | 30 mins.                               |                                                             | 0        |
| 5% gamma-BHC       | 0                                      | 73                                                          |          |
|                    | 15 mins.                               | 43                                                          |          |
|                    | 30 mins.                               | 15                                                          |          |

Exposures needed to reduce the availability of aldrin and dieldrin were much shorter than those required to reduce the availability of gamma-BHC. This selective action suggests that the hardening produced by ultra-violet light is of a different nature from that produced by increasing the U-F: alkyd ratio.

A comparison of various initial concentrations of aldrin, gamma-BHC and dieldrin in 50:50 films showed that contact and fumigant actions were proportional to the concentrations used. Biological and chemical methods were used to follow the change of concentrations of the volatile insecticides with time.

It has also been shown that the kind of surface treated can have a marked effect on the biological activity of the film. On many porous surfaces and on paint films the insecticidal action will be less than that expected from trials on non-porous surfaces.

55/12. AN INVESTIGATION OF SOME FACTORS CONTROLLING THE EFFICIENCIES OF  
NON-CRYSTALLIZING INSECTICIDES IN RESIN FILMS.  
PART 2. FILMS CONTAINING VARIOUS RESINS AND PLASTICIZERS

F. BARLOW and A.B. HADAWAY. Colonial Insecticides Research Unit,  
Porton.

This paper presents the results of experiments which were carried out to determine the efficiency of various film-forming resins, with and without the addition of plasticizers, as carriers for insecticides.

As regards materials and methods, the procedures outlined in Part 1 of this report were followed. Some resins contained drying oils and 0.03% of cobalt as the linoleate was added to the solutions of these resins.

The resins used and the solutions prepared from them are shown in Table I.

TABLE I

| <u>Name of resin</u> | <u>Type</u>                                      | <u>Per cent. of<br/>solids in solu-<br/>tion</u> | <u>Density of<br/>solution</u> |
|----------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------|
| C.460                | Coumarone-indene                                 | 64                                               | 1.022                          |
| M.4000               | Maleic                                           | 64                                               | 0.997                          |
| Alloprene B.         | Chlorinated rubber                               | 30                                               | 1.009                          |
| Beckosol 2911        | Drying oil alkyd, 45 per<br>cent. fatty acids.   | 35                                               | 0.939                          |
| Beckosol 1320        | Drying oil alkyd,<br>rosin modified.             | 35                                               | 0.964                          |
| Styresol 9255        | Styrenated alkyd.                                | 30                                               | 0.938                          |
| U-F, BE.610          | Butylated urea-<br>formaldehyde                  | 40                                               | 0.969                          |
| Bedacryl 122X        | Polymethyl methacrylate.                         | 30                                               | 0.938                          |
| Wresinol 6           | Drying oil, alkyd, 60 per<br>cent fatty acids.   | 50                                               | 0.944                          |
| Texilac 190          | Co-polymer of styrene and<br>ethyl methacrylate. | 40                                               | 0.947                          |

The plasticizers used were di n-octyl phthalate, D.O.P.; tri-cresyl phosphate, T.C.P.; butyl stearate; triacetin, Cerechlor 1, a chlorinated paraffin, and BA.502, a castor oil alkyd.

Biological test methods were as described in Part I.

Preliminary experiments were carried out with various base resins without the addition of plasticizers, and the results obtained are shown in Table II.

TABLE II

Tribolium castaneum exposed to the vapour from resin films containing 10 per cent. aldrin.

| <u>Resin</u>  | <u>Age of<br/>film</u> | <u>Mean percentage kill after exposure<br/>of.....hrs.</u> |          |          |          |           |
|---------------|------------------------|------------------------------------------------------------|----------|----------|----------|-----------|
|               |                        | <u>1</u>                                                   | <u>2</u> | <u>4</u> | <u>8</u> | <u>16</u> |
| C.460         | 1 day                  |                                                            |          | 1        | 3        | 2         |
| M.4000        | 1 day                  |                                                            |          | 3        | 8        | 55        |
| Alloprene B   | 1 day                  |                                                            |          |          | 1        | 3         |
| Beckosol 2911 | 1 week                 |                                                            |          | 3        | 42       | 96        |

| <u>Resin</u>  | <u>Age of Film</u> | Mean percentage kill after exposure of.....hrs. |    |     |    |    |
|---------------|--------------------|-------------------------------------------------|----|-----|----|----|
|               |                    | 1                                               | 2  | 4   | 8  | 16 |
| Beckosol 1320 | 1 week             |                                                 |    | 2   | 25 | 96 |
| Styresol 9255 | 2 days             |                                                 |    | 53  | 98 |    |
|               | 1 week             |                                                 |    | 2   | 35 | 95 |
|               | 2 weeks            |                                                 |    |     | 8  | -  |
| U-F           | 1 day              | 57                                              | 98 | 100 |    |    |
|               | 1 week             |                                                 |    | 54  | 94 |    |
|               | 2 weeks            |                                                 |    |     | 7  | 9  |
| Bedacryl 122X | 1 day              | 10                                              | 45 | 95  |    |    |
|               | 1 week             |                                                 |    | 47  | 81 |    |
|               | 2 weeks            |                                                 |    | 16  | 76 |    |
|               | 6 weeks            |                                                 |    |     | 16 |    |
| Wresinol 6    | 1 day              | 34                                              | 85 | 100 |    |    |
|               | 1 week             |                                                 |    | 53  | 96 |    |
|               | 2 weeks            |                                                 |    | 42  | 85 |    |
|               | 6 weeks            |                                                 |    |     | 55 |    |
| Texilac 190   | 1 day              | 40                                              | 85 | 100 |    |    |
|               | 1 week             |                                                 | 44 | 89  |    |    |
|               | 2 weeks            |                                                 |    | 61  | 99 |    |
|               | 6 weeks            |                                                 |    |     | 81 |    |

Following from this, the rate of loss of aldrin from various U-F: alkyd resin mixtures containing 10% aldrin was investigated, and kills of Tribolium exposed to the vapour from the films are given in Table III. Despite the variability in results it may be concluded that 60:40 is the most suitable ratio of U-F: alkyd resin for films intended to hold fumigants at the 10% level.

TABLE III

Tribolium castaneum exposed to the vapour from U-F resin films containing 10 per cent. aldrin.

| <u>Ratio U-F:alkyd</u> | <u>Age of film</u> | Mean percentage kill after exposure of.....hrs. |    |    |   |   |    |
|------------------------|--------------------|-------------------------------------------------|----|----|---|---|----|
|                        |                    | 0.5                                             | 1  | 2  | 4 | 8 | 16 |
| 100:0                  | 1 day              | 25                                              | 54 | 92 |   |   |    |
|                        | 15 days            |                                                 |    |    |   | 9 |    |
|                        | 5 weeks            |                                                 |    |    |   | 0 | 2  |
|                        | 8 weeks            |                                                 |    |    |   |   | 1  |

| Ratio<br>U-F:alkyd. | Age of<br>film | Mean percentage kill after<br>exposure of.....hrs. |    |    |     |     |     |
|---------------------|----------------|----------------------------------------------------|----|----|-----|-----|-----|
|                     |                | 0.5                                                | 1  | 2  | 4   | 8   | 16  |
| 90:10               | 1 day          | 26                                                 | 56 | 90 |     |     |     |
|                     | 15 days        |                                                    |    |    |     | 32  |     |
|                     | 5 weeks        |                                                    |    |    |     | 1   | 48  |
|                     | 8 weeks        |                                                    |    |    |     |     | 8   |
| 80:20               | 1 day          | 34                                                 | 75 | 97 |     |     |     |
|                     | 15 days        |                                                    |    |    | 19  | 78  |     |
|                     | 5 weeks        |                                                    |    |    |     | 43  | 100 |
|                     | 8 weeks        |                                                    |    |    |     | 20  | 97  |
|                     | 12 weeks       |                                                    |    |    | 0   | 1   | 29  |
| 70:30               | 1 day          | 61                                                 | 92 |    |     |     |     |
|                     | 15 days        |                                                    |    | 21 | 67  |     |     |
|                     | 5 weeks        |                                                    |    |    | 53  | 99  |     |
|                     | 8 weeks        |                                                    |    |    | 40  | 97  |     |
|                     | 12 weeks       |                                                    |    |    | 30  | 82  | 100 |
| 60:40               | 1 day          | 70                                                 | 95 |    |     |     |     |
|                     | 15 days        |                                                    |    | 54 | 96  |     |     |
|                     | 5 weeks        |                                                    |    | 22 | 82  | 100 |     |
|                     | 8 weeks        |                                                    |    |    | 72  | 98  |     |
|                     | 12 weeks       |                                                    |    |    | 43  | 95  | 100 |
| 50:50               | 1 day          | 71                                                 | 95 |    |     |     |     |
|                     | 15 days        |                                                    |    | 74 | 100 |     |     |
|                     | 5 weeks        |                                                    |    | 8  | 67  | 94  |     |
|                     | 8 weeks        |                                                    |    |    | 9   | 55  |     |
|                     | 12 weeks       |                                                    |    |    | 1   | 1   | 11  |

Tests with films of some of the resins listed in Table I have shown that their toxicity can be increased by the addition of a plasticizer, and that as with U-F resin, the amount of plasticizer is an important factor in determining the availability of the contained insecticide.

Thus, the contact toxicity of 5% dieldrin in Alloprene B was increased considerably by the addition of 30% D.O.P. as can be seen from the results given in Table IV.

TABLE IV

Aedes aegypti exposed in contact with Alloprene B films containing 5 per cent. dieldrin, 1 day after application.

| Ratio<br>Alloprene B:<br>D.O.P. | Mean percentage kill after exposure<br>of..... mins. |    |     |
|---------------------------------|------------------------------------------------------|----|-----|
|                                 | 8                                                    | 16 | 32  |
| 100:0                           | 0                                                    | 0  | 0   |
| 90:10                           | 0                                                    | 0  | 0   |
| 80:20                           | 0                                                    | 15 | 70  |
| 70:30                           | 17                                                   | 82 | 100 |

Likewise, the kills of Tribolium exposed to aldrin vapour diffusing from films of mixtures of Alloprene B and Cerechlor 1 increases as the proportion of plasticizer increased (Table V).

TABLE V

Tribolium castaneum exposed to the vapour from Alloprene B films containing 10 per cent. aldrin, 1 day after application.

| Ratio<br>Alloprene B:<br>Cerechlor | Mean percentage kill after exposure<br>of.....hrs. |    |     |    |    |
|------------------------------------|----------------------------------------------------|----|-----|----|----|
|                                    | 1                                                  | 2  | 4   | 8  | 16 |
| 100:0                              |                                                    |    |     | 1  | 3  |
| 70:30                              |                                                    |    |     | 20 | 78 |
| 60:40                              | 1                                                  | 5  | 16  |    |    |
| 50:50                              | 28                                                 | 78 | 100 |    |    |

Reference to Table VI shows the addition of 10% D.O.P. was sufficient to increase the contact toxicity of films of Styresol 9255.

It would appear that if the resin itself is too impermeable the incorporation of a non-hardening plasticizer increases the permeability.

TABLE VI

Aedes aegypti exposed in contact with Styresol 9255 films containing 5 per cent. dieldrin.

| Ratio<br>Styresol:<br>D.O.P. | Age of<br>film | Mean percentage kill after<br>exposure of....mins. |    |     |    |
|------------------------------|----------------|----------------------------------------------------|----|-----|----|
|                              |                | 8                                                  | 16 | 32  | 64 |
| 100:0                        | 1 day          | 3                                                  | 55 | 100 |    |
|                              | 2 weeks        |                                                    | 0  | 3   | 53 |
|                              | 5 weeks        |                                                    |    | 0   | 8  |
| 90:10                        | 1 day          | 35                                                 | 95 |     |    |
|                              | 2 weeks        | 40                                                 | 98 |     |    |
|                              | 5 weeks        | 35                                                 | 88 | 100 |    |
| 80:20                        | 1 day          | 28                                                 | 90 |     |    |
|                              | 2 weeks        | 33                                                 | 98 |     |    |
|                              | 5 weeks        | 18                                                 | 73 | 100 |    |

The effect of different plasticizers was studied and it has been shown that for a given resin: plasticizer ratio, both initial and residual insecticidal activity vary considerably with different plasticizers.

This point is illustrated in Tables VII and VIII where mixtures of 70:30 Alloprene B: plasticizer containing butyl stearate or D.O.P. were more effective than those containing T.C.P. or Cerechlor.

TABLE VII

Aedes aegypti exposed in contact with films of 70:30 Alloprene B mixtures containing 5 per cent. dieldrin, 1 day after application.

| <u>Plasticizer.</u> | Mean percentage kill after exposure<br>of....mins. |    |    |
|---------------------|----------------------------------------------------|----|----|
|                     | 8                                                  | 16 | 32 |
| Butyl stearate      | 28                                                 | 93 |    |
| D.O.P.              | 18                                                 | 78 |    |
| T.C.P.              |                                                    | 0  | 3  |
| Cerechlor           |                                                    | 0  | 0  |

TABLE VIII

Tribolium castaneum exposed to the vapour from films of 70:30 Alloprene B mixtures containing 10 per cent. aldrin, 1 day after application.

| <u>Plasticizer</u> | Mean percentage kill after exposure of...hrs. |    |    |    |    |
|--------------------|-----------------------------------------------|----|----|----|----|
|                    | 1                                             | 2  | 4  | 8  | 16 |
| Butyl stearate     | 25                                            | 83 | 97 |    |    |
| D.O.P.             | 30                                            | 83 | 97 |    |    |
| T.C.P.             |                                               |    | 4  | 40 | 99 |
| Cerechlor          |                                               |    | 2  | 10 | 75 |

TABLE IX

Aedes aegypti exposed in contact with films of 70:30 U-F mixtures containing 5 per cent. dieldrin.

| <u>Plasticizer</u> | <u>Age of film</u> | Mean percentage kill after exposure of....mins. |    |     |     |
|--------------------|--------------------|-------------------------------------------------|----|-----|-----|
|                    |                    | 4                                               | 8  | 16  | 32  |
| Triacetin          | 1 day              | 15                                              | 83 | 100 |     |
|                    | 2 weeks            |                                                 | 0  | 10  | 78  |
| Alkyd              | 1 day              | 8                                               | 73 | 100 |     |
|                    | 2 weeks            |                                                 | 0  | 8   | 58  |
| Cerechlor          | 1 day              | 0                                               | 45 | 98  |     |
|                    | 2 weeks            |                                                 | 8  | 50  | 100 |
| D.O.P.             | 1 day              | 0                                               | 38 | 95  |     |
|                    | 2 weeks            |                                                 | 20 | 93  | 100 |
| T.C.P.             | 1 day              | 0                                               | 35 | 98  |     |
|                    | 2 weeks            |                                                 | 33 | 98  | 100 |

TABLE X

Tribolium castaneum exposed to the vapour from films of 70:30 U-F mixtures containing 10 per cent. aldrin.

| <u>Plasticizer</u> | <u>Age of film</u> | Mean percentage kill after exposure of....hrs. |    |     |    |    |
|--------------------|--------------------|------------------------------------------------|----|-----|----|----|
|                    |                    | 0.5                                            | 1  | 2   | 4  | 8  |
| Triacetin          | 1 day              | 38                                             | 89 | 100 |    |    |
|                    | 1 week             |                                                | 2  | 23  | 90 |    |
|                    | 2 weeks            |                                                |    |     | 35 | 97 |
|                    | 4 weeks            |                                                |    |     | 1  | 4  |

| <u>Plasticizer</u> | <u>Age of film</u> | Mean percentage kill after exposure of....hrs. |    |    |     |    |
|--------------------|--------------------|------------------------------------------------|----|----|-----|----|
|                    |                    | 0.5                                            | 1  | 2  | 4   | 8  |
| Alkyd              | 1 day              | 8                                              | 52 | 94 |     |    |
|                    | 1 week             |                                                | 1  | 8  | 48  |    |
|                    | 2 weeks            |                                                |    |    | 50  | 99 |
|                    | 4 weeks            |                                                |    |    | 10  | 38 |
|                    | 8 weeks            |                                                |    |    | 13  | 53 |
| Cerechlor          | 1 day              | 9                                              | 56 | 96 |     |    |
|                    | 1 week             |                                                | 11 | 48 | 90  |    |
|                    | 2 weeks            |                                                |    | 42 | 79  |    |
|                    | 4 weeks            |                                                |    | 29 | 67  | 99 |
|                    | 8 weeks            |                                                |    | 9  | 46  | 96 |
| D.O.P.             | 1 day              | 4                                              | 43 | 88 |     |    |
|                    | 1 week             |                                                | 36 | 78 | 100 |    |
|                    | 2 weeks            |                                                | 31 | 76 | 98  |    |
|                    | 4 weeks            |                                                |    | 46 | 86  |    |
|                    | 8 weeks            |                                                |    |    | 9   | 52 |
| T.C.P.             | 1 day              | 9                                              | 54 | 98 |     |    |
|                    | 1 week             |                                                | 43 | 94 | 100 |    |
|                    | 2 weeks            |                                                | 41 | 90 | 100 |    |
|                    | 4 weeks            |                                                |    | 43 | 83  |    |
|                    | 8 weeks            |                                                |    |    | 13  | 54 |

Comparisons of various formulations were made, in which the contact toxicity of 5% dieldrin in various resin combinations containing varying proportions of plasticizers are shown in Table XI.

Films of resins containing a plasticizer were the most effective. Wresinol 6 and Texilac 190 were used with no plasticizers; Alloprene B and Styresol 9255 contained the optimum amount of D.O.P. and the standard 50:50 U-F: alkyd resin formulation performed slightly more effectively than the 70:30 Alloprene B: D.O.P. and the 90:10 Styresol 9255: D.O.P. formulations initially, none showing any appreciable toxicity change after 6 weeks.

TABLE XI

Aedes aegypti exposed in contact with resin films containing 5 per cent. dieldrin.

| <u>Formulation</u> | <u>Age of film</u> | Mean percentage kill after exposure of....mins. |    |     |    |
|--------------------|--------------------|-------------------------------------------------|----|-----|----|
|                    |                    | 4                                               | 8  | 16  | 32 |
| 50 U-F:            | 1 day              | 33                                              | 83 | 100 |    |
| 50 alkyd           | 2 weeks            | 5                                               | 54 | 98  |    |
|                    | 6 weeks            | 23                                              | 70 | 100 |    |

TABLE XI -- contd.

| <u>Formulation</u> | <u>Age of film</u> | Mean percentage kill after exposure of....mins. |    |     |     |
|--------------------|--------------------|-------------------------------------------------|----|-----|-----|
|                    |                    | 4                                               | 8  | 16  | 32  |
| 70 Alloprenene:    | 1 day              |                                                 | 38 | 85  | 100 |
| 30 D.O.P.          | 2 weeks            |                                                 | 13 | 80  | 100 |
|                    | 6 weeks            |                                                 | 40 | 95  | 100 |
| 90 Styresol:       | 1 day              |                                                 | 30 | 73  | 100 |
| 10 D.O.P.          | 2 weeks            |                                                 | 15 | 83  | 100 |
|                    | 6 weeks            |                                                 | 25 | 93  | 100 |
| Wresinol 6         | 1 day              | 20                                              | 65 | 100 |     |
|                    | 2 weeks            |                                                 | 0  | 18  | 78  |
|                    | 6 weeks            |                                                 | 0  | 20  | 88  |
| Texilac 190        | 1 day              | 0                                               | 20 | 63  |     |
|                    | 2 weeks            |                                                 | 0  | 20  | 85  |
|                    | 6 weeks            |                                                 | 0  | 30  | 95  |

TABLE XII

Tribolium castaneum exposed to the vapour from resin films containing 10 per cent. aldrin.

| <u>Formulation</u> | <u>Age of film</u> | Mean percentage kill after exposure of.....hrs. |    |    |     |     |     |
|--------------------|--------------------|-------------------------------------------------|----|----|-----|-----|-----|
|                    |                    | 0.5                                             | 1  | 2  | 4   | 8   | 16  |
| 50 U-F:            | 1 day              | 41                                              | 95 |    |     |     |     |
| 50 alkyd           | 8 days             |                                                 | 30 | 82 |     |     |     |
|                    | 15 days            |                                                 |    | 67 | 98  |     |     |
|                    | 4 weeks            |                                                 |    | 26 | 77  | 100 |     |
|                    | 8 weeks            |                                                 |    |    | 50  | 94  |     |
|                    | 12 weeks           |                                                 |    |    | 17  | 60  | 100 |
| 60 U-F:            | 1 day              | 37                                              | 89 |    |     |     |     |
| 40 alkyd           | 8 days             |                                                 | 13 | 52 |     |     |     |
|                    | 15 days            |                                                 |    | 28 | 93  | 100 |     |
|                    | 4 weeks            |                                                 |    | 15 | 62  | 99  |     |
|                    | 8 weeks            |                                                 |    |    | 58  | 98  |     |
|                    | 12 weeks           |                                                 |    |    | 30  | 94  | 100 |
| 70 Alloprenene B   | 1 day              | 8                                               | 62 | 98 |     |     |     |
| 30 D.O.P           | 8 days             |                                                 | 30 | 93 | 100 |     |     |
|                    | 15 days            |                                                 |    | 32 | 95  |     |     |
|                    | 4 weeks            |                                                 |    | 25 | 80  | 100 |     |
|                    | 8 weeks            |                                                 |    |    | 5   | 42  |     |
|                    | 12 weeks           |                                                 |    |    |     | 5   | 45  |

| Formulation  | Age of film. | Mean percentage kill after exposure of.....hrs. |    |    |    |    |     |
|--------------|--------------|-------------------------------------------------|----|----|----|----|-----|
|              |              | 0.5                                             | 1  | 2  | 4  | 8  | 16  |
| 90 Styresol: | 1 day        | 13                                              | 55 | 99 |    |    |     |
| 10 D.O.P.    | 8 days       |                                                 | 4  | 39 | 96 |    |     |
|              | 15 days      |                                                 |    |    | 52 | 99 |     |
|              | 4 weeks      |                                                 |    |    | 38 | 84 |     |
|              | 8 weeks      |                                                 |    |    | 1  | 8  |     |
|              | 12 weeks     |                                                 |    |    |    | 10 | 82  |
| Wresinol 6   | 1 day        | 1                                               | 9  | 70 |    |    |     |
|              | 8 days       |                                                 |    | 1  | 22 | 90 |     |
|              | 15 days      |                                                 |    |    | 13 | 86 |     |
|              | 4 weeks      |                                                 |    |    | 9  | 69 |     |
|              | 8 weeks      |                                                 |    |    | 2  | 15 |     |
|              | 12 weeks     |                                                 |    |    |    | 12 | 91  |
| Texilac 190  | 1 day        | 0                                               | 25 | 83 |    |    |     |
|              | 8 days       |                                                 | 0  | 15 | 82 |    |     |
|              | 15 days      |                                                 |    |    | 46 | 97 |     |
|              | 4 weeks      |                                                 |    |    | 44 | 97 |     |
|              | 8 weeks      |                                                 |    |    | 25 | 59 |     |
|              | 12 weeks     |                                                 |    |    | 5  | 45 | 100 |

It is evident from these experiments that the efficiency of resins as carriers of insecticides varies accordingly to the physical properties of the films produced.

Important characteristics which determine the availability of the contained insecticides are considered to be the rate and extent of hardening, and therefore, the permeability of the film.

The permeability may be increased by the addition of a non-hardening plasticizer, which gives increased availability of a contact insecticide and a higher rate of diffusion of a volatile insecticide.

With U-F: alkyd resins, if the proportion of alkyd plasticizer is increased the rate of loss of vapour is too high, but if it is decreased the films become impermeable. On the other hand, with other resins which do not tolerate such a high concentration of plasticizer, the maximum amount of a compatible plasticizer that still gives reasonably hard films is probably the most suitable.

#### 55/13. EXPERIMENTS WITH MIXTURES OF DIELDRIN AND GILSONITE (Reproduced whole).

A.B. HADAWAY (1955). Colonial Insecticide Research Unit, Porton, Wilts.

Gilsonite is a hard bitumen which yields brittle films when used alone in a paint. The suppliers of gilsonite suggest that the addition (79986)

of a softer bituminous material gives more flexible films. Three petroleum bitumens of varying hardness, Mexphaltes 400-500, 40/50 and H80/90 were therefore used. Mixtures of 80 per cent. gilsonite and 20 per cent. of each of the Mexphaltes by weight were dissolved in sufficient xylene to give solutions containing 45 per cent. by weight of the mixed resins. Enough dieldrin to give 20 per cent. by weight of insecticide based on the resin solids was added to each solution.

The solutions were painted on to glass plates at a rate of approximately 1.5 oz. per sq. yd., and after the solvent had evaporated the films were allowed to dry for one week. Crystal growth was now stimulated on each film either by rubbing or by confining 20 flour beetles under a Petri dish on the film for 4 hours. The number and size of crystals formed appeared to be about the same on all films. However, the formulation containing Mexphalte 40/50 gave a reasonably hard film while still retaining some flexibility, and for this reason this plasticizer was used in further tests.

Each of the following 6 formulations was painted on to three glass plates at the rate of 1.5 oz. per sq. yd.:-

50:50 urea-formaldehyde: alkyd resin containing 5, 10 or 20 per cent. dieldrin;

80:20 gilsonite: Mexphalte 40/50 containing 5, 10 or 20 per cent. dieldrin.

After the solvent evaporated, the films were allowed to dry and a batch of approximately 50 flour beetles (Tribolium castaneum) was confined under a Petri dish in contact with each film for 1, 2 or 4 hours. Mortality counts were made after storage in clean tubes for 5 days, with the following results:

| Resin<br>mixture | Dieldrin<br>conc. | Percentage kill after exposure of |    |     | hours |
|------------------|-------------------|-----------------------------------|----|-----|-------|
|                  |                   | 1                                 | 2  | 4   |       |
| 50:50            |                   |                                   |    |     |       |
| U-F:             | 5                 | 2                                 | 10 | 70  |       |
| Alkyd            | 10                | 4                                 | 71 | 100 |       |
|                  | 20                | 56                                | 98 | 100 |       |
| 80:20            |                   |                                   |    |     |       |
| Gilsonite:       | 5                 | 0                                 | 0  | 4   |       |
| Mexphalte.       | 10                | 2                                 | 10 | 58  |       |
|                  | 20                | 10                                | 59 | 96  |       |

The movements of the insects stimulated crystal formulation at the surface of some films, and the presence or absence of crystals at the end of the various exposure periods is indicated below:-

| <u>Resin mixture</u> | <u>Dieldrin conc.</u> | <u>Exposure time in hours.</u> |          |          |
|----------------------|-----------------------|--------------------------------|----------|----------|
|                      |                       | <u>1</u>                       | <u>2</u> | <u>4</u> |
| 50:50                |                       |                                |          |          |
| U-F:                 | 5                     | -                              | -        | -        |
| Alkyd,               |                       |                                |          |          |
|                      | 10                    | -                              | +        | +        |
|                      | 20                    | +                              | +        | +        |
| 80:20                |                       |                                |          |          |
| Gilsonite:           | 5                     | -                              | -        | -        |
| Mexphalte.           |                       |                                |          |          |
|                      | 10                    | -                              | -        | -        |
|                      | 20                    | -                              | -        | -        |

After storage of the plates for a further 24 hours some crystals had appeared at the surface of the U-F film containing 10 per cent. dieldrin on which beetles had been confined for 1 hour. No crystals had formed on U-F films containing 5 per cent. dieldrin. Crystals had also formed at the surface of gilsonite films containing 20 per cent. dieldrin on which beetles had been confined for 2 and 4 hours, but not on any of the other gilsonite films. Further batches of beetles were now confined on the various films, but kills were not significantly different from those obtained initially.

It may be concluded, therefore, that dieldrin cannot be stimulated to crystallize on the surface of 80:20 gilsonite:mexphalte 40/50 films so readily as it can on 50:50 U-F alkyd resin films; that films showing no surface crystallization may be insecticidal; and that gilsonite:mexphalte films are less insecticidal than the corresponding U-F; alkyd films. However, Gilsonite is a comparatively cheap material (current price 38/- per cwt.) and insecticidal surface coatings from dieldrin/gilsonite mixtures may well prove useful in some situations, e.g. timber protection.

(The sample of "Gilsonite" pure natural asphaltum, Selects Grade, was kindly supplied by Morris Ashby, Ltd., 10, Philpot Lane, E.C.3; and the samples of Mexphaltes by Shell-Mex and B.P. Ltd., Shell Mex House, Strand W.C.2.)

A.B. HADAWAY (1955). Colonial Insecticide Research Unit, Porton, Wilts.

Results with mixtures of dieldrin and gilsonite were obtained with a low insecticide to resin ratio. Another way of using resins in insecticide formulations is to add a small percentage of resin to a conventional 5 per cent. insecticide solution. Thus, a 5 per cent. DDT in kerosene solution normally crystallizes as rather large recumbent crystals. The addition of 0.5 per cent. coumarone resin to the solution modifies crystal growth so that projecting bunches of smaller crystals are formed. These are more effective biologically than the larger recumbent crystals.

It was thought worth while, therefore, to see if the same effect occurred with dieldrin solutions. Gilsonite was not very soluble in kerosene so a coumarone-indene resin C460 was used instead. Varying amounts of resin ranging from 1 to 400 per cent. by weight on the insecticide were added to a series of solutions of 5 per cent. dieldrin in power kerosene. These solutions were sprayed on to glass plates and allowed to dry. As with DDT, about 10 per cent. of resin by weight on the insecticide appeared to be about the best concentration to use. This amount caused a maximum decrease in crystal size, while larger amounts progressively reduced the total amount of crystals produced until, with 200 and 400 per cent. concentrations, the insecticide remained in solution in the resin film.

Screens used in bush against tsetse flies have usually been constructed of hessian sprayed with or dipped in DDT oil solution. Pieces of hessian were now sprayed with the following solutions at a dosage of 1000 mg. of insecticide per sq. ft.

1. 5 per cent. DDT in kerosene.
2. 5 per cent DDT and 0.5 per cent coumarone resin in kerosene.
3. 5 per cent. Dieldrin in kerosene.
4. 5 per cent. Dieldrin and 0.5 per cent. coumarone resin in kerosene.

After 2 to 3 days only the DDT solution containing resin had produced marked spontaneous crystallization. The hessian samples were now lightly rubbed. The DDT/resin solution again produced a dense deposit of crystals and this time the Dieldrin/resin solution also crystallized. The solutions without resin showed only slight induced crystallization.

Evidently the resin does not facilitate the crystallization of dieldrin to the same degree as it does that of DDT. However, the presence of resin does promote the crystallization of dieldrin after abrasion, and it may be useful to add this or a similar resin if hessian screens are to be treated with kerosene solutions.

(The coumarone-indene resin C460 was kindly supplied by British Resin Products, Ltd., 21, St. James Square, S.W.1.)

55/15. EVALUATION OF DUSTS AND SPRAYS FOR THE PROTECTION OF SHELLLED CORN FROM INSECT ATTACK.

A.C. APT. Entomology Research Branch, U.S. Department of Agriculture  
Bulletin E-875. April 1954.

The corn used in this work was grown in 1949 and had been stored, since the autumn of 1950, in bins of frame construction. The corn was infested with several species of grain beetles, the saw-toothed grain beetle, Oryzaephilus surinamensis (L). being predominant; no weevil infestation was found.

Various spray and dust formulations containing synergized pyrethrins, ryania, or lindane were applied to twenty-five 3,000-bushel bins of shelled corn at Beattie, Kans., in the fall of 1952, as the corn was transferred from one bin to another. Monthly samples from six points in each bin were taken through December 1953, and the insect populations were determined for each. No insects were found after treatment with a pyrethrins-piperonyl butoxide-talc dust at 100 pounds, or with ryania-n-propyl isome dust at 60 pounds per 1,000 bushels. The first formulation caused downgrading of the corn because of the inorganic base.

The insect population was held to a very low level by ryania, ryania-sulfoxide, and ryania-n-propyl isome dusts at 45 pounds or lindane-flour dusts at 60 pounds per 1,000 bushels. The ryania-sulfoxide formulation caused downgrading of the corn because of an objectionable odour.

Dusts of pyrethrins-sulfoxide-ground rice hulls and pyrethrins-piperonyl butoxide-corn cob flour at 100 pounds per 1,000 bushels and a spray containing pyrethrins-piperonyl butoxide-water applied at 10 gallons held insect population to a relatively low level. A spray containing pyrethrins-piperonyl butoxide-carbon tetrachloride and dusts containing lindane-flour applied at 45 pounds and pyrethrins-piperonyl butoxide-corn cob flour at 75 pounds per 1,000 bushels failed to inhibit the development of dangerous insect populations.

Tests in which insects were confined for 3 weeks on samples of grain taken 2, 4, 7, 9, and 11 months after treatment gave results that correlated closely with the populations in the bins.

The moisture content of corn treated with the water-base spray decreased rather than increased in the 3 weeks following application.

Ryania residues remained high after 7 months but were rather variable. Lindane residues after 3 months were only one-thirtieth to one fortieth of the amounts applied.

TABLE I

Spray and dust formulations applied to bins of shelled corn.

| Formulation                                                                                                                                    | Application<br>rate per<br>1,000 bushels | Bins<br>treated | Insecticide<br>applied |
|------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|-----------------|------------------------|
| <u>Percent</u>                                                                                                                                 | <u>Gallons</u>                           | <u>Number</u>   | <u>P.p.m.</u>          |
| <u>Sprays</u>                                                                                                                                  |                                          |                 |                        |
| 1. Pyrethrins-piperonyl butoxide<br>concentrate (5-50) . . . . . 5 )<br>Carbon tetrachloride . . . . . 93 )<br>Inert ingredients . . . . . 2 ) | 2                                        | 3               | 1.04                   |
| 2. Pyrethrins-piperonyl butoxide<br>concentrate (1-10) . . . . . 1.18 )<br>Water and emulsifier . . . . . 98.9 )                               | 8                                        | 3               | 1.23                   |
| <u>Dusts</u>                                                                                                                                   |                                          |                 |                        |
| <u>Pounds</u>                                                                                                                                  |                                          |                 |                        |
| 3. Pyrethrins . . . . . 0.05 )<br>Piperonyl butoxide . . . . . .80 )<br>Talc . . . . . 99.15 )                                                 | 100                                      | 3               | 0.89                   |
| 4. Pyrethrins . . . . . 0.08 )<br>Sulfoxide . . . . . 1.10 )<br>Ground rice hulls . . . . . 98.82 )                                            | 100                                      | 2               | 1.43                   |
| 5. Pyrethrins . . . . . 0.08 )<br>Piperonyl butoxide . . . . . 1.10 )<br>Corn-cob flour . . . . . 98.82 )                                      | 75<br>100                                | 1<br>1          | 1.07<br>1.43           |
| 6. Ryania (Ground stems) . . . . . 100 )                                                                                                       | 45<br>60                                 | 2<br>2          | 804<br>1071            |
| 7. Ryania (ground stems) . . . . . 95.8 )<br>Sulfoxide . . . . . 3.2 )<br>Inert material . . . . . 1.0 )                                       | 45<br>60                                 | 2<br>1          | 770<br>1026            |
| 8. Ryania (ground stems) . . . . . 95.8 )<br>n-Propyl isome . . . . . 3.2 )<br>Inert material . . . . . 1.0 )                                  | 45<br>60                                 | 2<br>1          | 770<br>1026            |
| 9. Lindane . . . . . 1.0 )<br>Wheat flour . . . . . 99.0 )                                                                                     | 45<br>60                                 | 1<br>1          | 8.1<br>10.7            |

TABLE II

Insect populations found in samples from bins of shelled corn treated with insecticide dusts and sprays in the fall of 1952, Beattie, Kans.

| Formulation                                                 | Dosage<br>per<br>1,000<br>bushels<br>Gallons | Number of insects per 1,000 grams of shelled corn |                          |                          |                   |                      |                      |                      |                    |
|-------------------------------------------------------------|----------------------------------------------|---------------------------------------------------|--------------------------|--------------------------|-------------------|----------------------|----------------------|----------------------|--------------------|
|                                                             |                                              | 1952                                              |                          |                          |                   | 1953                 |                      |                      |                    |
|                                                             |                                              | Sept.                                             | Oct.                     | Nov.                     | Dec.              | Jan.                 | Feb.                 | Mar.                 | Apr.               |
| 1. Pyrethrins-piperonyl<br>butoxide-carbon<br>tetrachloride | 2                                            | 16.0 <sup>1)</sup><br>14.6<br>7.3                 | 0.7<br>2.0<br>1.3        | 0.7<br>0<br>0            | 0<br>0<br>0.7     | 0.7<br>0<br>0        | 0<br>0<br>0          | 2.0<br>0<br>0        | 0<br>0<br>0        |
| 2. Pyrethrins-piperonyl<br>butoxide-water                   | 8                                            | 2.6<br>42.0<br>24.0                               | 0<br>0<br>1.3            | 0<br>0<br>0.7            | 0<br>0<br>0       | 0<br>0<br>0          | 0<br>0<br>0          | 0.7<br>0<br>1.3      | 0<br>0<br>0        |
| Pounds                                                      |                                              |                                                   |                          |                          |                   |                      |                      |                      |                    |
| 3. Pyrethrins-piperonyl<br>butoxide-talc                    | 100                                          | 3.3<br>22.0<br>66.6                               | 0<br>0<br>0              | 0<br>0.7<br>0            | -<br>-<br>-       | 0<br>0<br>0          | 0<br>0<br>0          | 0<br>0<br>0          | 0<br>0<br>0        |
| 4. Pyrethrins-sulfoxide-<br>ground rice hulls               | 100                                          | -<br>-                                            | 19.3<br>27.3             | 0<br>0                   | -<br>-            | 0<br>0               | 0<br>0               | 0<br>0               | 1.3<br>0           |
| 5. Pyrethrins-piperonyl<br>butoxide corncob<br>flour        | 75<br>100                                    | -<br>-                                            | -<br>-                   | 16.6<br>22.0             | 0.7<br>0          | 0<br>0               | 0<br>0               | 0<br>0               | 0<br>0             |
| 6. Ryania                                                   | 45<br>60                                     | 106.6<br>33.3<br>19.3<br>30.6                     | 7.4<br>2.0<br>2.6<br>4.0 | 4.6<br>1.3<br>0.7<br>2.0 | -<br>-<br>-<br>-  | 6.0<br>0<br>0.7<br>0 | 1.3<br>0<br>0<br>0.7 | 4.6<br>0<br>0.7<br>0 | 0<br>1.3<br>0<br>0 |
| 7. Ryania-sulfoxide                                         | 45<br>60                                     | -<br>-<br>148.0<br>107.3                          | 4.3<br>0<br>0            | 5.3<br>0<br>0            | -<br>-<br>-       | 0.7<br>0<br>0        | -<br>-<br>-          | 0.7<br>0<br>0        | 0<br>0<br>0        |
| 8. Ryania <u>n</u> -propyl isome                            | 45<br>60                                     | -<br>-<br>4.6<br>3.3                              | 30.6<br>0<br>0           | 0<br>0<br>0              | -<br>-<br>0       | 0<br>0<br>-          | -<br>-<br>0          | 0<br>0<br>0          | 0<br>0<br>0        |
| 9. Lindane-flour                                            | 45<br>60                                     | -<br>-                                            | -<br>-                   | 16.0<br>1.3              | -<br>-            | 0<br>0               | 0<br>0               | 0<br>0               | 0<br>0             |
| Check                                                       |                                              | 24.0<br>6.0<br>4.6                                | 24.0<br>6.0<br>4.6       | 25.3<br>8.0<br>2.6       | 2.6<br>9.3<br>2.6 | 6.0<br>10.0<br>0.7   | 15.3<br>0<br>1.3     | 4.6<br>2.7<br>2.7    | 6.0<br>2.7<br>0    |

1) The first figure recorded for each bin represents the number of insects per 1,000 grams of shelled corn just prior to treatment.

TABLE II (Cont'd.)

| Formulation                                                 | Dosage<br>per 1,000<br>bushels | Number of insects per 1,000 grams of shelled corn |                 |                    |                        |                                    |                                                              |                    |                  |
|-------------------------------------------------------------|--------------------------------|---------------------------------------------------|-----------------|--------------------|------------------------|------------------------------------|--------------------------------------------------------------|--------------------|------------------|
|                                                             |                                | 1953                                              | June            | July               | Aug.                   | Sept.                              | Oct.                                                         | Nov.               | Dec.             |
|                                                             |                                | May                                               |                 |                    |                        |                                    |                                                              |                    |                  |
| <u>Gallons</u>                                              |                                |                                                   |                 |                    |                        |                                    |                                                              |                    |                  |
| 1. Pyrethrins-piperonyl<br>butoxide-carbon<br>tetrachloride | 2                              | 0<br>0.7<br>0                                     | 2.6<br>0<br>0.7 | 1.3<br>0.7<br>0.7  | 73.3<br>15.3<br>19.3   | 36.0 <sup>2)</sup><br>35.3<br>15.3 | -<br>42.6<br>-                                               | -<br>-<br>-        | -<br>-<br>-      |
| 2. Pyrethrins-piperonyl<br>butoxide-water                   | 8                              | 0<br>0<br>0                                       | 1.4<br>0<br>0.7 | 0<br>0<br>0        | 12.6<br>0<br>0.7       | 4.0 <sup>2)</sup><br>2.6<br>2.0    | -<br>3.3<br>1.3                                              | -<br>0<br>0.7      | -<br>0.7<br>1.3  |
| <u>Pounds</u>                                               |                                |                                                   |                 |                    |                        |                                    |                                                              |                    |                  |
| 3. Pyrethrins-piperonyl<br>butoxide-talc                    | 100                            | 0<br>0<br>0                                       | 0<br>0<br>0     | 0<br>0<br>0        | 0<br>0<br>0            | 0<br>0 <sup>2)</sup><br>0          | 60.0 <sup>3)</sup><br>0<br>-                                 | -<br>-<br>-        | -<br>-<br>-      |
| 4. Pyrethrins-sulfoxide-<br>ground rice hulls               | 100                            | 0<br>0                                            | 0<br>0.7        | 0<br>23.3          | 1.3<br>0               | 3.0<br>3.3 <sup>2)</sup>           | 2.0<br>-                                                     | 2.6<br>-           | 1.3<br>-         |
| 5. Pyrethrins-piperonyl<br>butoxide-corn cob<br>flour       | 75<br>100                      | 0<br>0                                            | 0.7<br>0.7      | 8.0<br>0           | 64.0<br>6.6            | 4.6 <sup>2)</sup><br>8.0           | -<br>2.0                                                     | -<br>0             | -<br>0           |
| 6. Ryania                                                   | 45<br>60                       | 0<br>0<br>0                                       | 0<br>0.7<br>0   | 0<br>0<br>0        | 0.7<br>0<br>0.7<br>1.3 | 0.3 <sup>2)</sup><br>0.7<br>0      | -<br>0<br>0<br>0                                             | -<br>0<br>0<br>0.7 | -<br>0<br>0<br>0 |
| 7. Ryania-sulfoxide                                         | 45<br>60                       | 0<br>0<br>0                                       | 0<br>0<br>0     | 0<br>0.7<br>0      | 0<br>0.7<br>0.7        | 0.7<br>1.3<br>0                    | 0<br>2.6<br>0                                                | 0<br>0<br>-        | -<br>-<br>-      |
| 8. Ryania-n-propyl isome                                    | 45<br>60                       | 0<br>0<br>0                                       | 0<br>0<br>0     | 0<br>0<br>0        | 0<br>0<br>0            | 0<br>0.7<br>0                      | 0<br>0<br>0                                                  | 0<br>0<br>-        | 0<br>0<br>-      |
| 9. Lindane-flour                                            | 45<br>60                       | 0<br>0                                            | 2.0<br>0        | 8.0<br>0           | 52.6<br>1.3            | 1.3 <sup>2)</sup><br>0             | -<br>1.3                                                     | -<br>-             | -<br>-           |
| Check                                                       |                                | 3.3<br>2.7<br>2.7                                 | 5.3<br>0<br>0.7 | 18.0<br>0.7<br>0.7 | 126.7<br>5.3<br>6.0    | 108.0<br>40.0<br>60.0              | 20.0 <sup>2)</sup><br>7.3 <sup>2)</sup><br>1.3 <sup>2)</sup> | -<br>-<br>-        | -<br>-<br>-      |

- 2) Bin fumigated the middle of September 1953; September samples taken after fumigation
- 3) This infestation attributed to a wet area beneath a leaky portion of the roof.

J. ROBINSON. Colonial Insecticides Research Unit, Arusha.

This interim report presents details of the initial experiments which were carried out at Kawanda, and later at Arusha Chini, Lyamungu and Mringa.

In the Kawanda experiments, DDT and BHC were used with two types of application. In one type the insecticide was hoed in and in the other the insecticide was left on the surface of the soil.

Samples of treated soil were taken a  $1\frac{1}{2}$  screw auger fitted with a cylindrical sleeve, which prevented the light top soil from falling off the auger, and, in surface treatments, prevented the surrounding insecticide from falling into the samples. Samples were taken at two depths, viz. 0-6" and 6-12", ten samples being taken at each time interval. Tables 1, and 2 show the results of this experiment.

TABLE I

Insecticide hoed into the soil

| Insecticide | Dosage applied                                        | Mean Insecticide content of 0-6" layer p.p.m. (dry soil) | Time since insecticide applied, days | Rain-fall since application | Correlation * Coefficient                            |
|-------------|-------------------------------------------------------|----------------------------------------------------------|--------------------------------------|-----------------------------|------------------------------------------------------|
| BHC         | Agrocide 2<br>3.5% BHC<br><br>10 oz/yd <sup>2</sup> ) | 111<br>(Range 38-388)                                    | 13                                   | 2.27                        | -0.297,<br><br>0.1 > P > 0.05<br><br>Not significant |
|             |                                                       | 78<br>(Range 55-143)                                     | 42                                   | 5.67                        |                                                      |
|             |                                                       | 85<br>(Range 21-245)                                     | 78                                   | 9.69                        |                                                      |
|             |                                                       | 46<br>(Range 9-143)                                      | 99                                   | 17.56                       |                                                      |
| DDT         | Kensil<br>5% DDT<br><br>10 oz/yd <sup>2</sup> )       | 292<br>(Range 144-526)                                   | 6                                    | 0.88                        | -0.233<br><br>P > 0.1<br><br>Not significant         |
|             |                                                       | 143<br>(Range 42-317)                                    | 34                                   | 5.67                        |                                                      |
|             |                                                       | 172<br>(Range 44-330)                                    | 67                                   | 9.55                        |                                                      |
|             |                                                       | 167<br>(Range 87-303)                                    | 96                                   | 17.56                       |                                                      |

TABLE 2

Insecticide applied to surface only

| Insecticide | Dosage applied                                      | Mean insecticide content of 0-6" layer, p.p.m. (dry soil) | Time since insecticide applied, days | Rain-fall since application | Correlation <sup>15</sup> Coefficient                         |
|-------------|-----------------------------------------------------|-----------------------------------------------------------|--------------------------------------|-----------------------------|---------------------------------------------------------------|
| DDT         | Kensil 5% DDT<br><br>10 oz/yd <sup>2</sup>          | 240<br>(Range 140-300)                                    | 0                                    | 0                           | -0.538, d.f.<br>36<br><br>P < .001,<br><br>highly significant |
|             |                                                     | 190<br>(Range 123-382)                                    | 2                                    | 1.5                         |                                                               |
|             |                                                     | 101<br>(Range 11-280)                                     | 29                                   | 5.45                        |                                                               |
|             |                                                     | 89<br>(Range 19-280)                                      | 56                                   | 7.53                        |                                                               |
| BHC         | Agrocide 2<br>3.5% BHC<br><br>10 oz/yd <sup>2</sup> | 192<br>(Range 113-280)                                    | 0                                    | 0                           | -0.725, d.f.<br>36<br><br>P < .001,<br><br>highly significant |
|             |                                                     | 74<br>(Range 25-160)                                      | 13                                   | 0.93                        |                                                               |
|             |                                                     | 24<br>(Range 0-66)                                        | 29                                   | 8.58                        |                                                               |
|             |                                                     | 25<br>(Range 12-55)                                       | 55                                   | 11.61                       |                                                               |

<sup>15</sup>The significances of the correlation coefficients are calculated on the assumption that the regression of insecticide upon time is linear - an assumption which, in the light of later work, is improbable.

From these results it can be seen that the hoed in insecticides showed no significant decrease, whereas insecticides applied to the surface showed a significant decrease, and this decrease was felt to be due to volatilisation, although the possibility of insecticide being washed down into the soil should be considered.

Due to several factors such as the crude method of insecticide distribution, the experimental techniques used and the method of sampling, the experiment at Kawanda was discontinued.

A new experimental technique has now been evolved, which is based on the experience gained in the earlier work and is as follows: about 20 l. of soil are spread in trays and air dried by exposure to the sun. Stones and roots are removed and the soil ground to a fairly

fine powder using a maize grinder. The soil is mixed with the requisite amount of insecticide in a drum mixer. This consists of a five gallon drum fitted with a square (6" x 6") entry plate at one end. Two rows of "teeth" have been brazed on the inside. Two right-angle brackets are fitted centrally on opposite sides of the drum and by this means the drum can be spun round on a wooden frame. To mix the insecticide, 9 l. of dry soil are run into the drum at the same time as the requisite amount of insecticide. The drum is then revolved fifty times, ten times in each direction alternately; it is then rocked from side to side for fifty times. The contents of the drum are removed and a further 9 litres of soil mixed with insecticide. Halves of each batch of soil are then mixed together using the same technique, the remaining halves are added and the whole 18 l. mixed as before.

The samples of soil are taken as the whole batch is removed from the drum and the insecticide content determined. This technique gives a fairly uniform insecticide distribution, as can be seen from the initial figures obtained from the various insecticide mixes.

The insecticides used were Agrocide 7 (20% BHC) 2.5% Aldrin dust, and chlordane. Experimental plots have been placed at three sites.

(a) Arusha Chini, altitude 2,300 ft, annual rainfall approximately 17". Two types of plots have been used here, ordinary surface plots and plots in irrigation furrows. The latter are irrigated every three weeks. The soil here is of the sodium clay type with hard-pan in places.

(b) Lyamungu, altitude 4,100 ft., annual rainfall approximately 70". The soil here is volcanic origin and is characterised by low exchangeable potassium ion content.

(c) Mringa, altitude 4,700 ft., annual rainfall approximately 35". This is also a soil of volcanic origin, but of a more recent formation than that at Lyamungu. As a result it has a high exchangeable potassium ion content.

Samples were taken from the plots at various intervals, usually two soil compartments were sampled at depths of 0-1", 1-2" and 2-3". The results are given below. The amount of insecticide originally mixed was such as to give a content comparable with local concentration obtained in spot insecticide application. The results are given in Tables 3-6.

TABLE 3

Persistence of Insecticides in soil plots in furrows,  
Arusha Chini

|                       | Mean Insecticide content, p.p.m. (dry soil) |      |      |                    |      |      |                    |      |      |
|-----------------------|---------------------------------------------|------|------|--------------------|------|------|--------------------|------|------|
|                       | Aldrin                                      |      |      | BHC                |      |      | Chlordane          |      |      |
| Initial               | 568(Range 514-616)                          |      |      | 535(Range 477-716) |      |      | 356(Range 309-414) |      |      |
| Weeks since treatment | Depth of layer sampled                      |      |      |                    |      |      |                    |      |      |
|                       | 0-1"                                        | 1-2" | 2-3" | 0-1"               | 1-2" | 2-3" | 0-1"               | 1-2" | 2-3" |
| 1                     | 427                                         | 527  | 456  | —                  | —    | —    | —                  | —    | —    |
| 2                     | —                                           | —    | —    | 370                | 408  | 411  | 284                | 308  | 280  |
| 3                     | 475                                         | 524  | 474  | —                  | —    | —    | —                  | —    | —    |
| 6                     | —                                           | —    | —    | 227                | 347  | 336  | 241                | 263  | 256  |
| 7                     | 290                                         | 430  | 474  | —                  | —    | —    | —                  | —    | —    |
| 8                     | —                                           | —    | —    | 186                | 355  | 350  | —                  | —    | —    |
| 10                    | —                                           | —    | —    | 138                | 267  | 354  | 155                | 231  | 263  |
| 11                    | 205                                         | 399  | 435  | —                  | —    | —    | —                  | —    | —    |
| 21                    | —                                           | —    | —    | 110                | 269  | 259  | 114                | 188  | 196  |
| 22                    | 186                                         | 397  | 398  | —                  | —    | —    | —                  | —    | —    |
| 26                    | —                                           | —    | —    | 97                 | 240  | 281  | 167                | 246  | 220  |
| 30                    | —                                           | —    | —    | 73                 | 268  | 371  | 155                | 214  | 205  |
| 31                    | 141                                         | 422  | 392  | —                  | —    | —    | —                  | —    | —    |
| 34                    | —                                           | —    | —    | 104                | 231  | 273  | 140                | 248  | 252  |
| 35                    | 201                                         | 381  | 354  | —                  | —    | —    | —                  | —    | —    |
| 38                    | —                                           | —    | —    | 60                 | 164  | 267  | 128                | 205  | 211  |
| 39                    | 122                                         | 376  | 419  | —                  | —    | —    | —                  | —    | —    |
| 42                    | —                                           | —    | —    | 70                 | 192  | 219  | —                  | —    | —    |
| 49                    | —                                           | —    | —    | 50                 | 127  | 323  | 127                | 188  | 163  |
| 50                    | 170                                         | 344  | 404  | —                  | —    | —    | —                  | —    | —    |

In the 0-1" layer, the rate of loss for all three insecticides is much greater than that of the deeper layers, and this attributed to the higher soil temperature at or near the surface. The amount of insecticide in any layer remaining after a given time is approximately proportional to the square root of the time has elapsed since the soil was treated.

The comparative rates of loss of the three insecticides are in the order BHC chlordane aldrin, but definite conclusions cannot be drawn until the regression lines have been calculated.

TABLE 4

## Persistence of Insecticides in soil, surface plots

Arusha Chini

| Initial               | Mean Insecticide content, p.p.m. (dry soil) |      |      |                    |      |      |                    |      |      |
|-----------------------|---------------------------------------------|------|------|--------------------|------|------|--------------------|------|------|
|                       | Aldrin                                      |      |      | BHC                |      |      | Chlordane          |      |      |
|                       | 196(range 172-219)                          |      |      | 132(Range 115-155) |      |      | 251(range 241-258) |      |      |
| Weeks since treatment | Depth of layer sampled                      |      |      |                    |      |      |                    |      |      |
|                       | 0-1 "                                       | 1-2" | 2-3" | 0-1 "              | 1-2" | 2-3" | 0-1 "              | 1-2" | 2-3" |
| 5                     | 126                                         | 110  | 67   | -                  | -    | -    | -                  | -    | -    |
| 6                     | -                                           | -    | -    | 53                 | 41   | 36   | 150                | 131  | 100  |
| 11                    | 95                                          | 101  | 53   | -                  | -    | -    | -                  | -    | -    |
| 13                    | -                                           | -    | -    | 31                 | 22   | 18   | 128                | 159  | 92   |
| 18                    | -                                           | -    | -    | 13                 | 8    | 8    | 134                | 112  | 52   |
| 24                    | -                                           | -    | -    | 18                 | 14   | 10   | 143                | 135  | 69   |

Here again, the rate of loss of insecticide is BHC > chlordane > aldrin, although these results are characterised by an inversion in the insecticide content i.e. the lower layers contain less than the upper layers, a phenomenon which has not been observed in any of the other soil experiments.

TABLE 5

Persistence of insecticides in soil, Iyamungu.

|                       | Mean Insecticide content, p.p.m. (dry soil) |      |      |                    |      |      |                    |      |      |
|-----------------------|---------------------------------------------|------|------|--------------------|------|------|--------------------|------|------|
|                       | Aldrin                                      |      |      | BHC                |      |      | Chlordane          |      |      |
| Initial               | 195(Range 171-232)                          |      |      | 144(Range 136-151) |      |      | 198(Range 188-205) |      |      |
| Weeks since treatment | Depth of layer sampled                      |      |      |                    |      |      |                    |      |      |
|                       | 0-1"                                        | 1-2" | 2-3" | 0-1"               | 1-2" | 2-3" | 0-1"               | 1-2" | 2-3" |
| 5                     | 146                                         | 144  | 125  | 78                 | 121  | 95   | 133                | 111  | 118  |
| 9                     | 149                                         | 155  | 147  | 74                 | 90   | 83   | 115                | 138  | 136  |
| 18                    | 72                                          | 73   | 75   | 26                 | 55   | 57   | 14                 | 89   | 74   |
| 22                    | 114                                         | 120  | 104  | 30                 | 50   | 60   | 97                 | 116  | 104  |
| 29                    | 93                                          | 110  | 101  | 21                 | 50   | 50   | 97                 | 104  | 74   |
| 33                    | 79                                          | 93   | 78   | 25                 | 37   | 38   | 85                 | 99   | 87   |
| 37                    | 66                                          | 91   | 90   | 24                 | 37   | 58   | 66                 | 87   | 81   |
| 41                    | 52                                          | 72   | 66   | 18                 | 34   | 47   | 61                 | 80   | 72   |
| 46                    | 75                                          | 86   | 75   | 27                 | 45   | 43   | 76                 | 86   | 82   |

(79986)

The rates of loss are in the order, BHC, chlordane, aldrin, although there is not the same variation in rate of loss with depth as occurred in the furrow plots at Arusha Chini. This may be due to differences in soil structure, which in turn, is probably due to the greater retaining powers of the sodium clay at Arusha Chini and the regular irrigation.

Data from the Mringa plots does not, in general, cover the same time interval as at Arusha Chini and Lyamungu, the approximate order of the rate of loss of insecticide at Mringa is BHC > chlordane > aldrin > dieldrin > toxaphene > DDT.

TABLE 6

## Persistence of Insecticides in soil, Mringa

| Initial               | Mean Insecticide content, P.p.m. (dry soil) |                        |                        |                        |                        |                        |  |  |  |  |  |  |
|-----------------------|---------------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|--|--|--|--|--|--|
|                       | Aldrin                                      | BHC                    | Chlordane              | DDT                    | Dieldrin               | Toxaphene              |  |  |  |  |  |  |
|                       | 234<br>(Range 210-248)                      | 146<br>(Range 124-177) | 185<br>(Range 164-198) | 213<br>(Range 199-221) | 209<br>(Range 202-220) | 276<br>(Range 260-291) |  |  |  |  |  |  |
| Weeks since treatment | Depth of layer sampled                      |                        |                        |                        |                        |                        |  |  |  |  |  |  |
|                       | 0-1" 1-2" 2-3"                              | 0-1" 1-2" 2-3"         | 0-1" 1-2" 2-3"         | 0-1" 1-2" 2-3"         | 0-1" 1-2" 2-3"         | 0-1" 1-2" 2-3"         |  |  |  |  |  |  |
| 4                     | 123 148 159                                 | - - -                  | 83 108 120             | 154 166 174            | - - -                  | - - -                  |  |  |  |  |  |  |
| 6                     | - - -                                       | - - -                  | - - -                  | - - -                  | 93 123 132             | 128 165 188            |  |  |  |  |  |  |
| 7                     | - - -                                       | 58 78 104              | - - -                  | - - -                  | - - -                  | - - -                  |  |  |  |  |  |  |
| 11                    | - - -                                       | - - -                  | - - -                  | - - -                  | 85 103 101             | - - -                  |  |  |  |  |  |  |
| 12                    | - - -                                       | - - -                  | - - -                  | 166 178 187            | - - -                  | 102 149 161            |  |  |  |  |  |  |
| 13                    | - - -                                       | 43 61 77               | - - -                  | - - -                  | - - -                  | - - -                  |  |  |  |  |  |  |
| 15                    | 148 183 157                                 | - - -                  | 125 147 120            | - - -                  | - - -                  | - - -                  |  |  |  |  |  |  |
| 16                    | 83 159 132                                  | - - -                  | 74 126 130             | - - -                  | - - -                  | - - -                  |  |  |  |  |  |  |
| 22                    | - - -                                       | - - -                  | - - -                  | 104 172 177            | 96 108 135             | 124 159 198            |  |  |  |  |  |  |
| 24                    | - - -                                       | 38 63 96               | - - -                  | - - -                  | - - -                  | - - -                  |  |  |  |  |  |  |
| 25                    | 86 107 120                                  | - - -                  | 64 77 86               | - - -                  | - - -                  | - - -                  |  |  |  |  |  |  |
| 29                    | 63 92 98                                    | - - -                  | 46 63 61               | - - -                  | - - -                  | - - -                  |  |  |  |  |  |  |
| 33                    | 94 95 87                                    | - - -                  | 67 64 61               | - - -                  | - - -                  | - - -                  |  |  |  |  |  |  |
| 44                    | 62 78 92                                    | - - -                  | 49 59 79               | - - -                  | - - -                  | - - -                  |  |  |  |  |  |  |

All the experiments so far carried out are based on high insecticide concentrations in an attempt to study the behaviour of insecticides applied by the spot technique. Future work will be concerned with concentrations comparable with those used in broadcast applications.

Soil temperature studies will also be made, and laboratory experiments of absorption and desorption of insecticides by various types of soils started.

#### 55/17. SOME PHYSICAL PROPERTIES OF A GRANULAR INSECTICIDE

D. YEO and H.H. COUTTS. Colonial Insecticide Research Unit, Arusha. March, 1955.

In order to investigate the use of granular insecticides to control the seasonal increases in mosquito population in Dar-es-Salaam, an examination of various factors affecting this problem was undertaken.

Aircraft were to apply the granular material, and the immediate requirement was a suitable aircraft installation to ensure an effective distribution of the granular insecticide.

This granular material was supplied by the Shell Company, and contained 5% by weight of dieldrin, and although the size distribution of the granules was constant, the proportion of dieldrin varied. The bulk density of the material was found to be 1.22g/cc., and a count of a weighed sample gave a figure of  $2.03 \times 10^6$  granules per pound.

A dry-sieving of the material revealed that about 80% of the granules were retained on B.S. sieves 30 and 40 relatively small percentages being retained on B.S. sieves 60 and 80, and less than 1% passed the 80 mesh sieve.

Flow-rates from various apertures were determined, and a hopper was constructed, 3 ft. square at the top tapering at an angle of  $45^\circ$  to an aperture 2 inches square at the bottom, the bottom aperture being fitted with a wooden sliding gate.

From the experiments carried out with apparatus of this type, it appeared that the design of an aircraft installation would not involve any major engineering problems. It was found that basically, a hopper is required whose walls have a slope greater than  $32^\circ$  and a sliding gate which is readily adjusted to enable various delivery apertures to be used. This gate could be operated by a system of rods and levers leading to a control lever in the cockpit. It was thought that some care would have to be exercised in the design of the sliding gate to ensure that the granules did not interfere with its movement.

With a swath width of 12 yards, nominal dosages of about 3 lbs. per acre and flying speeds of approximately 80 m.p.h., the emission rates will be of the order of 0.3 lb. per second, with apertures of approximately 0.5 sq. in. in cross section.

55/18. THE ERADICATION OF GLOSSINA PALLIDIPES FROM ZULULAND BY CHEMICAL MEANS.

R. du TOIT and O.G.H. FIEDLER, Onderstepoort Laboratory, Transvaal and E.B. KLUGE, Nagana Research Laboratory, Zululand, (Paper I.S.C.T.R. (54)18 presented to the International Scientific Committee for Trypanosomiasis Research, 1954). Reproduced whole.

At the last meeting of this Committee in Lourenco Marques between the 25th and 30th September, 1952, a statement was presented regarding the progress made with the eradication of tsetse fly species in Zululand up until July 1952.

The present report must be regarded in the light of a further progress report in which is recorded the final elimination of Glossina pallidipes from Zululand and the eradication of G. brevipalpis from its area of limited distribution within the Hluhluwe game reserve and surroundings.

In the Onderstepoort Journal of Veterinary Research, Vol. 26 No.3 has appeared a comprehensive account of the principles underlying the eradication campaign undertaken together with a detailed description of the methods of insecticide dispersion employed and this has no doubt by now been perused by all those interested. It is left to us, therefore, merely to record the trends observed in the final disappearance of the flies and discuss the practicability of the methods employed in their application to other infested areas as well as to give some details as to the costs involved.

At the time of presenting the last statement in Lourenco Marques on the course of this campaign it could not be appreciated of course, that actual eradication of G. pallidipes had in fact been achieved in the Umfolozi reserve. The capture of a single specimen of this species in May 1952, represented the last fly taken in Umfolozi and since that date no single specimen has been recorded from the 22 groups of bait cattle of 2 each, subsequently increased to 23, which has constituted the method of survey employed and which has been continued to date.

During the colder months of June and July 1952 aerial applications of BHC in smoke form were discontinued and a new contract with our contractors was entered into for the summer season's activities from August 1952 to March 1953.

In the Hluhluwe game reserve, which was treated simultaneously with the Umfolozi reserve or, rather, within the same monthly cycle, eradication of the two species of tsetse flies present, namely G. pallidipes and G. brevipalpis, proceeded more slowly. The reason may be found in the difficult mountainous nature of the terrain as has been described previously, which necessitated the use of helicopters to negotiate those parts inaccessible to the fixed wing type of aircraft.

Due to an unfortunate accident with one of the two helicopters available in September 1952, which resulted in the total loss of this machine, the helicopters were withdrawn from service. The result was a severe setback in insecticide applications in the northern mountainous areas of the reserve until another method of negotiating these hilly sections could be found. Fortunately a solution was forthcoming in making use of a light fixed-wing type of aircraft, the Piper Super-Cub, whose phenomenal rate of climb and manoeuvrability made it possible to replace the helicopters with this type of aircraft which proved itself capable of negotiating the entire terrain efficiently and at a much lower cost.

The setback in the operations occasioned by the withdrawal of the helicopters and the delay which resulted until another method of dealing with the mountainous areas could be found may have been responsible for the slight deterioration in the fly position which manifested itself during February, March and April 1953. In spite of these difficulties, however, final eradication was achieved in May 1953 as subsequently transpired although there was no way of knowing this at the time.

As was customary aerial applications were discontinued again during the colder winter months of June and July and a final series of BHC smoke applications was undertaken from August 1953 to the end of January 1954. Insecticide applications were confined to the Hluhluwe game reserve during this final contract as Umfolozi had rendered nil returns since May 1952. Use was made of 4 Piper cruisers for the more level areas and 2 Piper Super-Cubs for the mountainous sections.

The following table records the fly catches taken in Hluhluwe from August 1952 to January 1954 when aerial spraying ceased.

HLUHLUWE GAME RESERVE

|           | Harris traps<br>(470) |      | Bait cattle<br>(28 groups) |      | Totals |      | Remarks                       |
|-----------|-----------------------|------|----------------------------|------|--------|------|-------------------------------|
|           | G.P.                  | G.B. | G.P.                       | G.B. | G.P.   | G.B. |                               |
| 1952 Aug. | -                     | 1    | -                          | 1    | -      | 2    |                               |
| Sept.     | -                     | -    | -                          | 1    | -      | 1    | Helicopters<br>withdrawn      |
| Oct.      | 2                     | -    | -                          | -    | 2      | -    |                               |
| Nov.      | -                     | -    | 1                          | 2    | 1      | 2    |                               |
| Dec.      | -                     | -    | 2                          | 3    | 2      | 3    |                               |
| 1953 Jan. | -                     | -    | -                          | -    | -      | -    | 1 G.brev.<br>reported seen.   |
| Feb.      | -                     | -    | 3                          | 7    | 3      | 7    |                               |
| March     | -                     | -    | 2                          | 4    | 2      | 4    |                               |
| April     | -                     | -    | 2                          | 2    | 2      | 2    |                               |
| May       | -                     | -    | -                          | 1    | -      | 1    | Last fly                      |
| June      | -                     | -    | -                          | -    | -      | -    | No application                |
| July      | -                     | -    | -                          | -    | -      | -    | No application                |
| Aug.      | -                     | -    | -                          | -    | -      | -    |                               |
| Sept.     | -                     | -    | -                          | -    | -      | -    |                               |
| Oct.      | -                     | -    | -                          | -    | -      | -    |                               |
| Nov.      | -                     | -    | -                          | -    | -      | -    | 1 tsetse<br>reported seen     |
| Dec.      | -                     | -    | -                          | -    | -      | -    |                               |
| 1954 Jan. | -                     | -    | -                          | -    | -      | -    | Aerial applica-<br>tion ended |
| Totals    | 2                     | 1    | 10                         | 21   | 12     | 22   |                               |

G.P. = *Glossina pallidipes*

G.B. = *Glossina brevipalpis*

In a campaign of the nature undertaken in Zululand where extensive use was made of mechanical equipment it may be expected that difficulties chiefly in respect of mechanical failures will occur. When these are considered together with the obstacles presented by the terrain itself together with periods of adverse climatic conditions when it is sometimes difficult to adhere rigidly to schedules, it must be expected that total eradication of an insect species such as the tsetse fly will not always proceed strictly according to plan. Theoretically, when the breeding localities of *G. pallidipes* have been located and accurately mapped by the pupal-casing survey methods described elsewhere it should be possible to achieve elimination with approximately eight applications of insecticide, possibly even less, provided the coverage of the breeding localities is sufficiently thorough to ensure the destruction of the adult flies present during each application. This is

practically never the case, however, and, as has been pointed out previously, small numbers of flies will survive one or more applications either by escaping contact with the insecticide in the area sprayed or by movement into sections already dealt with a day or two previously.

The results achieved in Zululand, where at this stage it is felt that complete eradication of G. pallidipes and G. brevipalpis, the latter species in its habitats in the Hluhluwe game reserve and surroundings only, has actually been achieved, seem to have demonstrated clearly the practicability of the methods employed. Furthermore, the underlying theory upon which they were based appears to have been correct in so far that the elimination of the species in their permanent breeding haunts will result in their elimination from the entire area infested by them. In the case of G. pallidipes this has amounted to the treatment of somewhat under 200 square miles to achieve eradication in an area some 7000 square miles in extent.

The value of aircraft for work of this nature appears to have been established beyond question and in particular the method of smoke or exhaust aerosol dispersion of insecticide. The advantage lies in the fact that extensive areas are capable of being dealt with in the shortest possible time by a method which, both from the point of view of the air personnel and the controlling ground staff, is eminently practical, entails the least labour and may be said to be almost fool proof. By this means reduction of the population density of flies is achieved rapidly and this in turn limits or drastically reduces dispersion of flies from breeding into dispersion areas. The cycles of insecticide applications should be rigorously adhered to thus preventing any further breeding and total elimination must result.

An aspect of the campaign which may be of considerable significance is the question of the role played by the hyperparasites of Glossina. This matter has been discussed in a paper recently published in the Onderstepoort Journal of Veterinary Research wherein it was shown that the Bombyliid, Thyridanthrax brevifacies Hesse appears to play an important role in limiting the tsetse fly population in Zululand at certain times. Evidence was obtained that this parasite, by virtue of its high degree of susceptibility to insecticides in smoke form, tends to be eliminated more quickly than its hosts. It may be concluded from this that in a campaign designed for the eradication of a tsetse fly species by the method advocated insecticide applications should be continued until eradication has been achieved as the danger exists that a rapid build up in the population could occur from the individuals remaining in the absence of the limiting influence of parasitism.

In how far the methods employed in Zululand are applicable to the closely related savannah species Glossina morsitans still remains to be proved. An opportunity was offered one of us to study the habitat of G. morsitans in the Urungwe reserve of South Rhodesia under both dry and wet season conditions with the object of advising the Rhodesian Government on the application of the methods employed so

successfully in Zululand. We would like to draw a comparison, therefore, between these two tsetse fly habitats and consider the possibilities of control offered by the application of the aerial approach to the problem.

In Zululand, with its predominantly thorn scrub (*Acacia*) type of vegetation amongst which many species of evergreen trees and shrubs occur the seasonal change in vegetational cover is not very marked and the optimum time for the commencement of insecticide applications, therefore, is August or the onset of the warmer weather. As has been emphasized in previous publications the advent of warmer weather in spring coincides with the mass hatching of pupae whose rate of development has been retarded during the colder months of May, June and July. The result is that at this time the maximum number of adult flies in relation to unhatched pupae in the ground is found. Insecticidal applications are best commenced during August and continued with throughout the summer months until final eradication is achieved.

In Southern Rhodesia the biotope of *Glossina morditans* comprises the *Brachystegia*-*Isoberlinia* type of woodland which is entirely leafless during the dry season and in which *G. morsitans* is unable to exist at this time. The evergreen-fringed drainage channels and rivers or streams constitute the only shelter available to the fly during the dry season with the result that heavy concentrations occur in these areas which are extremely limited in extent in relation to the leafless woodland. Where termite mound vegetational associations occur, which contain considerable evergreen species, patchy distribution of *G. morsitans* occurs but again, in relation to the *Brachystegia* woodland these are generally of limited extent and can be easily coped with by means of aircraft.

It is believed, but perhaps not yet substantiated, that these areas of evergreen bush in the biotope of *G. morsitans* constitute what have been called the permanent breeding haunts of *G. pallidipes* in Zululand. Whereas the accurate determination of these permanent breeding areas of *G. pallidipes* can be identified and their limits determined satisfactorily only by means of pupal-casing surveys as were conducted in Zululand, this procedure may prove to be unnecessary in Southern Rhodesia in the case of *G. morsitans*. In the dry season the evergreen-fringed riverines stand out clearly especially from the air, and no difficulty exists in locating and treating them. In the wet season, however, with the *Brachystegia* woodland in full flush no clear differentiation exists from the aerial angle between the two types of vegetation. In any case dispersion of *G. morsitans* throughout the woodland at this time makes aerial application inadvisable and of little if any value nor is it possible, as a rule, to operate satisfactorily on the ground in so far as survey work is concerned due to the state of the roads during the rains.

An additional consideration which should not be lost sight of is the distribution of the bulk of the game during the dry season. The

evergreen thickets usually represent those areas where water may be found and also afford the only cover available to game so that concentrations of fly are likely to occur in such localities where at the same time the concentration of game constitutes the only dependable food supply. From the point of view of aerial applications of insecticide this relationship should not be disturbed as the higher and more stricted the fly concentration is the more readily can it be dealt with.

The question of costs have been discussed in some detail in the article previously referred to except those of the Piper Super-Cubs.

Costs are extremely difficult to assess or to predict as so much depends on such factors as site of operations in relation to a permanent base, transportation of material to the site, operation and maintenance of vehicles, personnel etc.

Both the Piper Cruisers and Super-Cubs are capable of operating from small rough landing strips and it is obvious that these should be situated as close to the areas to be treated as possible so as to reduce unproductive flying to a minimum.

In the light of our experience in Zululand actual flying costs with the Piper Cruisers amounted to 6-7 pence per acre per application. This figure is based on the fact that about half of the actual flying time only can be used for actual insecticide application.

Insecticide amounts to 8.84 pence per acre. A figure of 15.54 pence per acre per application is arrived at, therefore, for aerial application with Piper Cruisers. It must be taken into consideration that this figure is for flying and insecticide only and takes no account of the many other charges associated with the operation. These, however, would vary from place to place.

The cost connected with the operation of the Piper Super-Cub is approximately 50% higher, namely 23.6 pence per acre per application.

In order to arrive at an estimate of the cost involved in eradicating a species of tsetse fly from a given locality the extent of the actual breeding areas which require treatment must be known. In the case of G. pallidipes in Zululand the areas actually treated comprised rather less than 3% of the region infested. It would appear from the evidence at our disposal at present that the breeding or concentration centres of G. morsitans in the dry season, which represent the areas requiring treatment, in relation to the area infested by it in the wet season are of extremely limited extent. These dry season habitats present no great difficulty in treating from the air. It is held, therefore, that regions constituting the wet season habitat of this species which may comprise many thousands of square miles in extent could readily and within a short period be freed of fly with a limited number of aircraft at comparatively low cost by means of the aerial application of insecticides.

The experience gained over a period of almost 9 years of operations in Zululand during which use has been made of many different types of aircraft, from heavy twin engined military types to light single engined commercial types, points very clearly to the light type of aircraft as offering the greatest economy together with the best record of serviceability and efficiency. For inaccessible hilly or mountainous terrain special types of light aircraft of high performance and manoeuvrability are available which can with advantage and at much lower cost replace helicopters or methods of dispersing insecticide from the ground such as insecticidal smoke generators, fog dispersing apparatus and dusting.

#### 55/19. PERSISTENCE OF PARATHION RESIDUES ON GLASS PLATES.

J. ROBINSON. Colonial Insecticide Research Unit, Arusha.

In this interim report, experiments are described and some results are given, of the persistence of parathion (98.8% purity) exposed on glass plates both in the shade and in the sun.

The analytical method used for estimating the residual parathion was by the colorimetric determination of sodium p-nitrophenoxide after preliminary alkaline hydrolysis.

Results obtained from exposures to sunlight are shown in Table I and as can be seen, the rate of loss of parathion appears to vary with the initial dosage which would seem to indicate that the film thickness of the deposit is an important factor. Deposits exposed to the sun contained traces of a brown tar, which was removed by the use of hydrogen peroxide during hydrolysis.

TABLE I

Persistence of Parathion deposits on glass plates exposed to sunlight.

| Days<br>Exposed | Trial 1                        |        | Trial 2        |        |
|-----------------|--------------------------------|--------|----------------|--------|
|                 | Mean Parathion<br>present, mg. | % Loss | Mean Parathion | % Loss |
| 0               | 12.65                          | —      | 1.265          | —      |
| 1               | 9.9                            | 22     | —              | —      |
| 2               | 9.7                            | 23     | —              | —      |
| 4               | 8.4                            | 34     | —              | —      |
| 5               | —                              | —      | .46            | 64     |
| 11              | 5.3                            | 58     | —              | —      |
| 12              | —                              | —      | Nil            | 100    |
| 21              | 1.9                            | 85     | —              | —      |

Rate of loss of parathion from exposures in the shade are given in Table II.  
(79986)

TABLE IIPersistence of Parathion deposits on glass plates in the shade.

| Days<br>Exposed | Trial 1                        |        | Trial 2                        |        |
|-----------------|--------------------------------|--------|--------------------------------|--------|
|                 | Mean Parathion<br>present, mg. | % Loss | Mean Parathion<br>present, mg. | % Loss |
| 0               | 12.65                          | -      | 1.265                          | -      |
| 5               | -                              | -      | 0.93                           | 26     |
| 8               | 10.2                           | 20     | -                              | -      |
| 13              | -                              | -      | 0.94                           | 26     |
| 16              | 9.2                            | 27     | -                              | -      |

It is considered that at least two factors may be contributing to the increased rate of loss of parathion viz. a) higher temperature of the deposit, leading to increased volatilisation, and b) photo-chemical decomposition especially by ultra-violet light. The brown tar which was formed is probably due to this factor.

These experiments will be extended to include a study of the persistence of deposits on vegetation.

(Specially written for P.A.N.S. by G. W. WOOD, Colonial Pesticides Information Service).

The use of synthetic resins for the preservation of biological specimens has been developed to the stage that a brief review of some of the current methods and materials may be of interest.

The methods which have been used employ (a) embedding techniques and (b) plastic casts.

With the former technique, the specimen is completely encased in a clear block of resin, which can be trimmed to any convenient size, and it is claimed that the specimen may be preserved in this way for an indefinite period.

One such example of this method, which is commercially available in the form of a kit of the necessary materials is the "Marco Embedding Kit"<sup>1</sup>). In this process, the embedding resin which is used is an unsaturated polyester type of synthetic, mixed with an accelerator and a catalyst to ensure hardening in a reasonable time, a plasticizer being incorporated to reduce the possibility of cracking.

The resin mixture is poured into a mould or metal container to the desired depth and allowed to harden. This should be complete in about three hours at 65°F, and embedding should not be carried out at temperatures above 80°F or below 60°F.

The specimen is now placed on this hardened layer, and it is emphasised that there is no need to dehydrate the specimen, since it can be transferred from formalin or spirit and embedded immediately, provided its surface is dry.

A further quantity of the embedding resins, accelerator and plasticizer is mixed and poured slowly over the specimen, sufficient resin mixture being used to submerge the specimen to a depth of at least  $\frac{1}{8}$  inch below the level of the resin. Special care must be taken at this stage not to trap air bubbles underneath the specimen. After the second layer of embedding mixture has hardened, the cast block is ejected from the mould, and the tacky surface is washed rapidly with acetone. The block, containing the specimen can be cut with a hacksaw to the required size, and the sawn surfaces rubbed down with emery cloth. These operations must be carried out within a few hours after the resin has hardened, and while it is still fairly soft and workable. After a day or two, the surface of the block can be buffed to a high polish using fine abrasives and a high speed polishing mop.

Using this technique, insects, small fish, and botanical specimens can be rapidly and permanently embedded in a transparent block of plastic material.

Flowers, when embedded in this way, tend to lose their colour, which is due partly to the presence of the catalyst (an oxidising agent) and partly due to the rise in temperature of the casting during the hardening process. A method has been worked out for preserving the shape and colour of flowers prior to embedding<sup>2)</sup>, which employs two solutions, one containing thiourea and sodium citrate, and the other containing thiourea and citric acid, both solutions using tertiary butyl alcohol as the solvent. Blue or green flowers are immersed in the first solution, red or pink flowers are treated with the second solution, and flowers of intermediate colours are immersed in a mixture of the two solutions. After immersion, the flowers are carefully dried in a desiccator and when completely dry they may be embedded by the technique outlined above.

Other resins have been successfully employed for embedding: thus Moore<sup>3)</sup> describes the use of methyl methacrylate particularly for preserving insect specimens, Spilner<sup>4)</sup> also describes the use of acrylic resins using embedding techniques.

Acrylic resins can however, be used by techniques employing a thin plastic cast, and this technique has been successfully employed in the preservation of botanical specimens such as leaves, flowers, etc., and has been fully described by Burton<sup>5)</sup>.

This process, which is analogous to the "cocoon" process in industry, consists in forming a thin acrylic plastic cast of the plant specimen, which in most cases, remains inside the cast, drying to a shrunken skeleton. This method is claimed to preserve thin plant tissues, and provides a translucent replica over thicker tissues for tinting.

The acrylic resin dissolved in chloroform with a retarder, to control evaporation, is applied either by spray or dipping techniques.

As the degree of hardness and tensile strength of the resulting resin film are in part determined by conditions during polymerisation<sup>6)</sup>, whilst initial drying and setting of the plant specimen may be rapid, subsequent drying out should be slow, preferably in a cool dark place.

The stock solution is composed of 20% w/v of dry methyl methacrylate powder dissolved in a commercial chloroform or methylene dichloride. This stock solution is used for the preparation of working solutions by the addition of more solvent.

Dyes can be incorporated, suitable dyestuffs being the Solacet range, and certain members of the Duranol and Dispersion colours; alternatively coloured plastic off-cuts may be dissolved in solvent.

For many purposes straight acrylic/chloroform solution dries too rapidly to allow care in the hand-setting of the specimen. To overcome this disadvantage, thinner retarders are employed, such as carbon tetrachloride or xylene. Xylene was found to be very useful for field work in hot weather, but its use must be carefully controlled, since if

used at more than one eighth by volume of the working solution, buckling of the specimens may occur. Due regard must also be taken of the toxic nature of the vapours of both the solvents and the methacrylate monomers,<sup>7)</sup> and gloves should be worn on the hands.

For leathery leaves, a hollow-cast process may be used as follows: the leaves are dipped or brushed over with 15 to 20% solution two or three times at intervals of a few hours. The specimen is then allowed to dry off completely for twelve hours. The specimen is then given a partial heat cure by immersion in hot water at about 75 to 85°C. When opaque patches appear on the leaf surfaces, indicating that the acrylic film is separating from the leaf itself, the specimen is removed from the water and the heat-softened upper and lower casts eased away from the leaf by manipulation of the edges, and also by dissecting needles or fine scissors. When the upper and lower casts have been pulled back the tough leaf is cut off about half an inch from the petiole. The small section of leaf still attached serves to strengthen the joint between petiole and "plastic" leaf when the two casts have been united. A 10% solution is brushed over the inner surface of the lower cast. The upper cast is then pressed down gently, working from the edges, and matching indentations.

One problem in processing with the acrylic resins is considered to be the overall shrinkage of a methyl methacrylate film on a leaf with a large surface area. It is thought that this could be overcome by substitution of one of the epoxy resins which are claimed to be non-shrinking.

#### References

1. Marco Embedding Kit. Technical Leaflet No. 62.  
The complete kit costs 45/- and is obtainable from Messrs. Scott Bader & Co. Ltd., 109, Kingsway, London, W.C.2.
2. Practical Embedment of Flowers. C. E. Wright. Modern Plastics, Oct. 1951.
3. Embedding Specimens in Methyl Methacrylate. B. P. Moore. Museum's J., 53, (9), 219, 1953.
4. Embedding in Acrylic. A. J. Spilner. Modern Plastics, 31: 129, 1953.
5. Preservation of Botanical Specimens in Natural Form by a thin Plastic Cast. M. P. Burton, N.Z. J.Sci. Tech.B, 36, (5), 479, 1955.
6. Acrylics and other Synthetic Resins used in Dentistry. S. D. Tylman: F. A. Peyton. 1946, 76-7. J. B. Lippincott Co., Philadelphia.
7. Preservation of Agricultural Specimens in Plastics. G. R. Fessenden. 1949, Misc.Publ. U.S. Dept. Agric. 679.

LIST OF INDUSTRIAL PAMPHLETS (BRITISH)

THE AEROGRAPH COMPANY LTD. Lower Sydenham, London, S.E.26.

Spraying Equipment - Price List.

BEGG, COUSLAND & CO. LTD. 28 Victoria Street, Westminster, London, S.W.1.

Woven Wire Cloth.

BURT, BOULTON & HAYWOOD LTD. Agricultural and Horticultural Department,  
Crabtree, Manorway, Belvedere, Kent.

Parathion Spray. Information Bulletin No. 10.

BURT, BOULTON & HAYWOOD LTD. Paints Division. Brettenham House,  
Lancaster Place, Strand, London, W.C.2.

"Prince Regent's" Insecticidal Coatings.

COOPER, McDOUGALL & ROBERTSON LTD. Berkhamsted, Herts.

Control of Warbles in Cattle with Derris.

Modern Sheep Dipping.

Cooper's Sheep Dipping Baths.

Cooper's Head Fly Dressing.

Cooper's Maggot Dressing (New Type)

Cooper's Poultry Perch Paint (or Poultry Aerosol) against Red Mite.

Master the Sheep Maggot Fly with Cooper's Powder Fly Dip.

Control of Lice on Cattle with 'Gammexane'.

External Parasites of Poultry. Cooper's Poultry Booklet 3.

Ticks on Cattle.

The Cooper Drenching Gun.

The Cooper-Allman Sheep Spray Race.

COOPER, PEGLER & CO. LTD. Burgess Hill, Sussex.

Spraying and Dusting Machinery and Price List for 1955.

W. T. FRENCH & SON LTD. Mysto Works, Birmingham, 16.

Mysto Hose Fittings.

Mysto Sprayers.

Mysto Agricultural Appliances.

KENT ENGINEERING AND FOUNDRY LTD. Phoenix Works, Tovil, Maidstone,  
Kent.

K.E.F. Range of Equipment for the Protection of Crops  
throughout the World.

Kiekens-Dekker Shoulder Mounted Blowers

Lindane.

MICROSOL INDUSTRIES LTD. 11, Southampton Row, London, W.C.1.

Microsol Mechanical Fog Generators - Electric and Engine Driven.

Microsol 101 (Electric).

Microsol 202 (Electric).

Microsol 303 (Electric).

Microsol 304 (Engine Driven).

Microsol Model 304-D.

Microsol Model 403-D.

MORRIS ASHBY LTD. 10, Philpot Lane, London, E.C.3.

Gilsonite - Pure Natural Asphaltum.

Recommended Practice in Melting Up Gilsonite in Varnish Making.

THE MURPHY CHEMICAL COMPANY LIMITED. Wheathampstead, Herts.

Murphy Winter Washes 1954-55 with Notes on Orthocide Wettable  
(50% Captan).

Murphy Winter Washes - Price List 1954-55.

Cockroaches. Murphex Advisory Leaflet 10.

Blow-Flies in Slaughterhouses. Murphex Advisory Leaflet 11.

Dieldrin: the New Insecticide. Jan. 1955.

Malathion. Jan. 1955.

The Control of Pests of Stored Farm Produce. Murphex Advisory  
Leaflet 12.

Insecticides, Fungicides, Fumigants for Nurseryman.

The Control of Pests & Diseases of Farm & Market Garden Crops. 1955.

Murphy Fruit Growers' Booklet. 1955.

Price List - Spring 1955. Insecticides, Fungicides, Fumigants for  
Horticultural and Agricultural Use.

PETROCHEMICALS LIMITED. 170, Piccadilly, London, W.1.

Catalethe (Dichloroethane & Carbon Tetrachloride). Technical Service  
Leaflet No. 7.

PLANT PROTECTION LTD. Bolton House, 61, Curzon Street, Piccadilly,  
London, W.1.

Low Volume Spraying against Weeds, Pests, Diseases, Potato Haulm.

'Gammasan' - Seed Dressing against Flea Beetle.

'Mergamma' D - Seed Dressing against Wireworm and Disease.

Guide to Pests and Diseases of Fruits.

SCOTT BADER & CO. LTD. 109 Kingsway, London, W.C.2.

Marco Embedding Kit. For the Permanent Preservation of Exhibition  
and Scientific Specimens and Preparations. Technical Leaflet  
No. 62.  
Polyester Handbook.

SHELL CHEMICALS LIMITED. Norman House, 105-109 Strand, London, W.C.2.

Stages of Fruit Bud Development.  
The Spraying of Fruits and Hops. Revised Edition.  
Instruction Manual for the Shell D-D Injector Gun MK. III.

SOREX (LONDON) LIMITED. 6 Henrietta Place, London, W.1.

Lacquered Death to Cockroaches.  
Ripolac the Sorex Insecticidal Lacquer. Spray Equipment.  
Recent Advances in Rodent Control with Warfarin.  
Progress in Rodent Control.

THE STANDARDISED DISINFECTANTS CO. LTD. 23, Sloane Street, London, S.W.1.

Malathion - a valuable new Insecticide.  
A brief History of the Standardised Disinfectants Company Limited  
together with its Products & Services.  
Hexagerm Emulsion. Technical Information Sheet No. 3/2.

J. M. STEEL & CO. LTD. Kern House, 36/38, Kingsway, London, W.C.2.

'Celacol' - the Celanese Brand of Water-Soluble Cellulose Ethers.

SWINGFIRE LIMITED. 94/98 Petty France, London, S.W.1.

Swingfog SN6 - the combined Fogging and Spraying Machine.  
Swingfog Flame Thrower - Applications.

H. T. WATSON LIMITED. Victoria Road, Widnes, Lancs.

Spray Nozzles.

AGRICULTURAL SERVICES PTY. LTD. 274, Canterbury Road, Canterbury, N.S.W.  
Australia.

Control of Insect Pests in Bananas. Technical Information Sheet.  
Red Legged Earth Mites. Insect Pest Bulletin.  
Black Beetle. Insect Pest Bulletin.

MONSANTO CHEMICALS LIMITED. Special Products Department,  
Allington House, Allington Street,  
London, S.W.1.

Sapstain can be Prevented Simply and Economically with Santobrite.  
Penta is the Best Preservative for Timber.

LIST OF INDUSTRIAL PAMPHLETS (AMERICAN)

AMERICAN CYANAMID COMPANY. Agricultural Chemicals Division. 30,  
Rockefeller Plaza, New York 20, New York,  
U.S.A.

Malathion - Strawberries. July, 1954. Label Claims accepted by  
the Pesticide Regulation Section, U.S. Dept. Agric.

Malathion - Alfalfa. Ibid.

Report on Toxicology of Malathion Technical 95% (Regular Production.)

CARBIDE AND CARBON CHEMICALS COMPANY. A Division of Union Carbide and  
Carbon Corporation, 30 East 42nd  
Street, New York 17, N.Y. U.S.A.

Crag. Agricultural Chemicals.

Crag. Fly Repellent.

E.I. DU PONT DE NEMOURS & CO. (INC.). Grasselli Chemicals Department,  
Wilmington, Delaware, U.S.A.

90% Technical Methoxychlor Oil Concentrate: Fly Sprays and Aerosols.  
Technical Bulletin.

Use EPN 300 Insecticide carefully.

KOLKER CHEMICAL WORKS, INC. 80, Lister Avenue, Newark 5, N.J. U.S.A.

Kolker Acaricide K-101.

MONSANTO CHEMICAL CO. Organic Division, 1700 South Second St.,  
St. Louis 4, Mo. U.S.A.

Milmer 1. Physical, Chemical and Biological Properties.  
Technical Bulletin No. O-38.

A Guide to Formulating and Applying Milmer 1, a safe, effective  
Industrial Preservative.

Penta in Oil Solutions by Pressure Process for maximum Wood  
Protection.

ROHM & HAAS COMPANY. Agricultural & Sanitary Chemicals Dept.,  
222 Washington Square, Philadelphia 5,  
Pennsylvania. U.S.A.

Triton X-150 and Triton X-160 for better Performing Agricultural  
Emulsions. Technical Bulletin No. AG-13.

SPRAYING SYSTEMS CO. 3201 Randolph Street, Bellwood, Illinois, U.S.A.

Industrial Spray Nozzles and related Equipment. Catalogue No. 24.

VELSICOL CORPORATION. 330 East Grand Avenue, Chicago, Illinois, U.S.A.

Analysis of Soil for Chlordane Residue. Nov. 1953.

Colorimetric Determination of Technical Chlordane in Formulations.

LIST OF INDUSTRIAL PAMPHLETS (SWISS)

F. D. BERTHOUD, S. A. Vevey, Switzerland

Poudrex (Duster).

Vertical II, II D and Vertical 4. (Duster).



## NEWS ITEMS

### (xxi) TENTH INTERNATIONAL CONGRESS OF ENTOMOLOGY, MONTREAL, CANADA

The following announcement appeared in Canadian Entomologist, May, 1955.

The Tenth International Congress of Entomology will be held in Montreal from 17 to 25 August, 1956. The meetings will be held at McGill University and the University of Montreal.

#### OFFICERS

President, Dr. W. R. Thompson  
Secretary, Mr. J. A. Downes

Associate Secretary, Dr. W. G. Friend  
Treasurer, Mr. A. B.

#### SECTIONS

The Sections of the Congress have been arranged provisionally as follows:

- |                              |                                        |
|------------------------------|----------------------------------------|
| 1. Systematics               | 9. Arachnida and other land Arthropods |
| 2. Morphology and Anatomy    | 10. Agricultural Entomology            |
| 3. Physiology                | 11. Forest Entomology                  |
| 4. Behaviour                 | 12. Medical and Veterinary Entomology  |
| 5. Ecology                   | 13. Stored Products Entomology         |
| 6. Geographical Distribution | 14. Biological Control                 |
| 7. Genetics and Biometrics   | 15. Apiculture                         |
| 8. Palaeontology             |                                        |

These sections will, however, be interpreted so as to cover the whole range of entomological science. Symposia will be arranged in many of the sections. Further announcements will be made later.

#### EXCURSIONS

A visit to the Science Service Laboratories, Ottawa, and certain short excursions will take place during the Congress. Following the Congress, tours to a number of more distant laboratories and excursions for collecting will be possible.

A wide choice of accommodation in hotels, student residences, and guest houses will be available at prices ranging from \$2 to \$10 a night. Camping facilities are available at Macdonald College, about 25 miles from Montreal.

## CONGRESS MEMBERSHIP

The Congress fee will be \$15, with a reduction for accompanying members and student members. A charge will also be made for some of the excursions.

There will probably be limited dollar funds available for small grants-in-aid for living expenses for members who are not otherwise provided for. Such members are invited, when replying to this announcement, to ask for the form of application. Applications from members sponsored by governmental or commercial organizations, or from those residing in North America, cannot be entertained.

## MEMBERSHIP

Those wishing to receive further information with a view to attending the Congress should notify the Secretary as soon as possible. They will then receive the application forms and a booklet giving more particulars. These papers can be sent only to those who give the notification requested. Those who would like to receive a personal invitation are requested to apply to the Secretary.

J. A. DOWNES, Secretary,  
Division of Entomology,  
Science Service Building,  
Ottawa, Ontario,  
Canada.

## (xxii) WORLD HEALTH ORGANIZATION: SPECIFICATIONS FOR PESTICIDES AND THEIR FORMULATIONS

The Expert Committee on Insecticides met at Maracay, Venezuela, in September 1954 to consider revisions and additions to the Specifications which were published in December 1952 (World Health Organization Technical Report Series No. 54).

As a result of this meeting, the Fifth Report will be published shortly, and it is immediately apparent from the title that this report has now been extended beyond the field of insecticides.

Thus, new sections dealing with rodenticides and molluscicides have been added, and good progress has been made in establishing specifications for certain herbicides which are coming into increasing use in connection with the control of schistosomiasis and filariasis.

Specifications for rodenticides range from the classical arsenious oxide to the newer anti-coagulants, Warfarin and Coumachlor.

The insecticides section has been extensively revised, and specifications which were designated tentative in the fourth report have been raised to the status of full specifications since they have proved to be satisfactory in use. New tentative specifications have been established for dusting powders containing DDT or BHC and specifications for dusting powders for use against certain resistant lice have also been included. Various auxiliary chemicals e.g. synergists, anti-oxidants etc., which are either in use or coming into use in vector control programmes have been included.

Tentative specifications for three organo-phosphorus insecticides viz., diazinon, malathion and parathion have been drawn up, and the Committee has recommended that any organo-phosphorus insecticide which is developed and which is of low mammalian toxicity but having physical properties conferring a high degree of persistence, should be subjected to field trials by the World Health Organization as soon as possible in order that more dangerous materials may be replaced.

Reference is made to the work that has been sponsored by W.H.O. in connection with the tropical storage and dispersion stability (suspensibility) of water-dispersible powders. The results of this work have enabled the Committee to standardise a method for the determination of the suspensibility of all water-dispersible powders. Although the work so far carried out on this project has provided invaluable data, further tropical storage experiments on a carefully selected range of water-dispersible powders has been recommended in order to clarify outstanding points and supplement existing data. It is hoped that this will enable improved laboratory accelerated tropical storage tests to be drawn up.

#### (xxiii) NEW FLUORACETATE INSECTICIDE

A new fluoracetate derivative has recently been announced by Associated Fumigators Ltd. London, England.

This compound, fluoracetanilide, F.  $\text{CH}_2\text{CONHC}_6\text{H}_5$  has been given the code number "1082". Fluoracetanilide is described as a yellow waxy solid, melting point 75-76°C., and is sparingly soluble in water, about 1 part in 1000 at room temperature.

It is claimed that this material exhibits contact, fumigant and systemic insecticidal action, and preliminary tests have shown it to be effective against aphids.

It is intended that for systemic use, this compound will be introduced in the form of tablets.

Manufacture of this material is fully protected by patents owned by Associated Fumigators. "1082" was discovered by Dr. M. A. Phillips, one of the original discoverers of "M and B 693".

(xxiv) INSECTICIDE SPRAYING-EQUIPMENT

The Bulletin of the World Health Organization, Vol. 12, No. 3 (1955) contains the following articles on spraying equipment:-

SUGGESTED TECHNIQUES, EQUIPMENT, AND STANDARDS FOR THE TESTING OF HAND INSECTICIDE-SPRAYING EQUIPMENT, by L. B. HALL

The new demands placed upon application equipment by the introduction of modern insecticides have revealed the deficiencies of this equipment when required for continuous use on a large scale. If adequate equipment is to be produced, specifications must be based not only on basic materials tests but also on "use" tests, in which the conditions of field use are simulated.

The author outlines suggested techniques to be followed and standards to be adopted in testing the performance of compression sprayers and allied equipment, with reference to the following features; compression-sprayer tank fatigue; tank impact; pump resistance to bursting; pump resistance to collapse; pump friction; cut-off valve durability; constant-pressure valves; cut-off valve actuation; hose flexure; hose tension and bursting-pressure; hose friction; gaskets, valve faces, and similar non-metallic parts; nozzle-orifice erosion; and nozzle pattern.

NOZZLES OF INSECTICIDE SPRAYERS. COMMENTS FROM THE POINT OF VIEW OF MALARIA CONTROL, by F. W. KNIPE

Certain performance characteristics of the insecticide-sprayer nozzle tip and its relationship to the pressure regulator are discussed.

After analysing the effectiveness of residual spraying at various pressures, the author concludes that low-pressure application would best attain the pattern and rate of insecticide discharge laid down by the WHO Expert Committee on Insecticides.

(xxv) TOLERANCE LIMIT FOR LINDANE

In the Federal Register, March 11, 1955 the following tolerance has been set for lindane by the Food and Drug Administration:

"Where a tolerance of 5 parts per million for BHC is set, it shall be deemed applicable to commercial benzenehexachloride, which is a mixture of several isomers. If the gamma isomer, known as lindane, is used exclusively of other isomers, the tolerance shall be 10 parts per million".

This tolerance supplements the tolerances for pesticides listed in P.A.N.S. 1, (2), May, 1955.

(xxvi) PLANT PROTECTION INVESTIGATIONS, CYPRUS

(Reproduced from Department of Agriculture, Cyprus, Quarterly Review No. 37. Sept. 1954. Received June 1955).

Olive Fly (*Dacus oleae*. Gmel.)

An experiment is being carried out at Nicosia to test the effects of various concentrations of parathion against the insect in relation to the oil content of the fruit. The concentrations being used have .02, .04, .06, .08 and .1% of active ingredient. Each concentration is being applied to six randomised single trees. A small scale trial is being carried out at Kyrenia, using the preparations of Dieldrin and Chlorthion.

Grape Berry Moth (*Polychrosis botrana*. Schiff.)

The trial on methods of controlling the grape berry moth, described in the Quarterly Review covering April to June, 1954, was concluded. All the materials used gave satisfactory control of the third generation larvae. Diazinon, used at the rate of .016% active ingredient instead of .002% as for the second generation, gave control only slightly inferior to that obtained with .019% parathion.

Stink Bug. "*Vromousa*" (*Dolycoris baccarum*. L.)

The small scale laboratory trial was conducted at the Trikoukkia Station to test several insecticides against this pest. Potato leaves were dipped in suspensions of the insecticides and placed in cages, each containing about 50 adult insects. Counts of dead and living insects taken 48 hours later showed that parathion .045, .03 and .15% active ingredient gave 100%, 96% and 85% kills respectively. Dieldrin at .0625% active ingredient gave a 92% kill, while DDT at .156% proved ineffective.

### Citrus Mealy Bug (*Pseudococcus citri*. Risso.)

The trial described in the Quarterly Review for April to June, 1954, was concluded. Parathion .028, Diazinon .016 and DDT .125% sprays were applied to plots of 30 vines each. Each plot received one or two treatments and was replicated three times. The first treatment was made on June 18th after the insects had started moving from underneath the bark to the young twigs, clusters and roots. The second application was made on July 6th. Counts of infested and non-infested clusters, taken on July 20th, three days prior to harvest, revealed that parathion and Diazinon had given almost complete control of the insect. DDT had given no control and most plots treated with this material were more heavily infested than the untreated plots.

### Cryocide Trials

Cryocide (81% Cryolite) was included in the apple and grape spray and dust treatments at Kondea, Saitta and Trikoukkia, mainly for the purpose of investigating its phytotoxicity under local conditions. A small number of vines of different varieties were treated with Cryocide dust at Kondea (altitude 125 feet) and at Saitta (altitude 2,000 feet). Several varieties of apples were sprayed with Cryocide at Trikoukkia (altitude about 4,000 feet). No phytotoxic symptoms were developed in either the grape vines or apple trees at any of the above places.

### Miscellaneous

A small laboratory test is being carried out to test the effectiveness of pyrethrum/piperonyl-Butoxide dust as a seed dressing against the local pests of stored wheat.

The observations on the biology of Phloeotribus scarabaeoides, Bern., Dacus oleae, Gmel., Ceratitis capitata, Wied., and Phyllocoptruta oleivorus, Ashmead, are being continued.

## ABSTRACTS

### 55/20 COLONIAL INSECTICIDE RESEARCH UNIT ARUSHA, TANGANYIKA

K. S. HOCKING, et al., Progress Report No. 16, July 1954 to March 1955.

#### Experiments against tsetse flies

##### 1. The situation at Kikore:

Only one block remains at Kikore, the Galapo block, treated in November 1950 - January 1951. Mean catches are given below together with those for the hillside control.

| Apparent density                                  | May - Oct. 1954 | Nov. - Jan. 1955 |
|---------------------------------------------------|-----------------|------------------|
| <i>G. morsitans</i>                               | 1.6             | 0.3              |
| <i>G. swynnertoni</i> ( <i>morsitans</i> habitat) | 1.5             | 0.9              |
| <i>G. swynnertoni</i> (main habitat)              | 0.8             | 2.0              |
| Hillside control ( <i>morsitans</i> )             | 454             | 520              |

There has been a good deal of settlement in the block and besides cultivating the land the settlers have brought in herds of cattle, sheep, goats and donkeys. This settlement is probably the reason for the low fly densities compared with the previous year. Future catches will give information on the interaction of settlement and fly numbers rather than on the after-effects of the insecticidal treatment.

##### 2. Magugu:

This area was chosen as the site for a repeat of the Urambo fly dispersal experiment, the object being to establish the mean daily movement of *G. morsitans* in miombo woodland. Flies were transported to the area, marked, released and recaptured. The average movement at Urambo was 254 yards (minimum) for old males in the third hunger stage. Insufficient recaptures have been made at Magugu to date to reach a definite conclusion on fly movement but at least the work has shown that the method of transport (chilling to 8-10°C in a thermos flask for up to six hours) had no adverse effect on the flies.

##### 3. Behaviour of coarse aerosol clouds in woodland:

An investigation was made of the influence of a number of factors on the distribution of insecticide in woodland. A solution of DDT in oil was disseminated as a coarse aerosol by an aircraft and its behaviour traced by the mortality suffered by caged flies. The test insects were wild-caught *Musca* (*Eumusca*) *lusoria* Weid., and were more susceptible to the insecticide used than were the tsetse *G. palpalis fuscipes* Newst,

In open country complete kills were obtained with the standard rate of application for at least three hundred yards downwind of the line of emission, in all conditions of atmospheric stability.

A series of trials to test the possibility of treating very thin bush in comparatively high winds and slightly unstable conditions was spoilt by variations in the emission rate of the insecticide. It was shown, however, that quite small amounts of twigs upwind provided a considerable degree of protection to the test insects and that the kills in cages completely exposed on the upwind side of these trees was considerably less than at corresponding distances downwind in completely open country. There was evidence that in high winds and slightly unstable conditions penetration through the bushes was better than with moderate winds and small inversions, but there was mortality behind obstacles in both conditions.

Preliminary comparisons between the kill in the open and in continuous woodland (Acacia xanthoploea) showed that in the latter mortality was greatly reduced and did not approach that frequently obtained in practical large scale experiments in tsetse control. A search was made for factors which would increase the level of mortality.

Increased atmospheric stability caused greater average mortality at the expense of uniformity of kill. This was not due solely to decreasing swathe width due to lighter winds.

Large natural openings in the canopy assisted the penetration of insecticide in unstable conditions but in stable air the kill round and downwind of clearings was reduced compared with kills in unbroken woodland.

The principal factor in raising mortality to a generally high level, and at the same time reducing the variability was the summation of sublethal doses due to drifting downwind of the fringes of successive parallel swathe. In these trials summation of three swathes 75 yards apart produced a mean mortality of 84% for 75 yards downwind of the third run, which was the highest kill obtained in any trial.

Duplication of actual control procedure, involving covering the whole area of woodland with insecticide, showed that even so, and in conditions of low turbulence, there may be great unevenness in the kill obtained. Mortality varied between 21% and 100% and this irregularity was almost certainly due to unsteadiness of wind direction in the free air, a constant feature of the stable, non-turbulent, atmospheric conditions needed to give a high level of mortality.

In discussion the relation between these results and those obtained in practical control experiments is considered. It is concluded that the use of caged insects and the type of woodland chosen for these trials

(80952)

probably accounts for the comparatively low mortalities obtained in this investigation, but that this affects only the general level of mortality and not its variation from place to place.

(A full account of this work has been prepared for publication as No. 10 of the series on Aerial Applications in East Africa. The version given above is the authors' summary).

### Experiments against mosquitoes

#### 1. Experimental huts at Taveta

Few experiments have been carried out during the period under review, since it was expected that the whole area would shortly be treated as part of the Taveta-Pare Malaria Scheme. Further the huts are now rather dilapidated and seriously invaded by ants. Attempts to exclude these insects have been only partially successful and the interpretation of some treatments has been made difficult. BHC treatments suffer most since a large proportion of the mosquitoes killed fall to the floor. With Dieldrin treatments many of the affected mosquitoes die in the window traps and the effect of scavengers on the floor is less.

It has become clear during the last few months that there is a seasonal variation in the effectiveness of, at least, BHC and Dieldrin treatments. Percentage kills fall during the dry seasons, to rise again with the rains. This feature is also shown by "fumigant action" tests, and may have an important bearing on studies of acquired resistance.

The main results of the different hut treatments for the period under review, may be summarised briefly as follows:-

The BHC/urea formaldehyde resin treatment applied on 24th April 1953 was showing signs of deterioration the percentage mortality of female vectors having dropped to 75. The original deposit contained 233 mg. of 90% gamma isomer per square foot.

The 25% Dieldrin wettable powder applied to mud and sand plaster walls to give an original deposit of 77 mg. per sq. ft. was still giving about 70% mortalities 92 weeks later. On plain mud the treatment was less effective. A reinforcing effect by successive treatments was noted in some cases. Dieldrin sprayed on the mud floor only of a hut at 25 mg./sq.ft. gave 100% kills for two weeks and 12% in the third.

#### 2. New site for experimental huts

When all the houses at Taveta have been sprayed the above experiments will be continued at a new site which is being prepared at Magugu, 94 miles from Arusha.

### 3. Taveta Pare malaria eradication scheme.

The routine procedures of entomological assessment are well established. These include:

- (i) The month by month record of the mosquito population, by spray catching in nearly 300 houses.
- (ii) Salivary gland dissections for the measurement of infection in anopheles caught by precipitin tests.
- (iii) Determination by precipitin tests of the source of blood meal, whether human or animal, of anopheles found in houses or elsewhere.
- (iv) Regular hand and window trap catches in 16 paired experimental huts, half of which will remain untreated with the residual spray.
- (v) Estimation of the numbers of anopheles biting out of doors at night.

In addition, various other special entomological studies are in progress, including:

- (i) Measurement of the outdoor resting populations of anopheles in box shelters.
- (ii) Studies on the amount of A. gambiae feeding on cattle and other animals.
- (iii) Studies in the age composition of the anopheline population.
- (iv) Measurement of anopheline populations in areas not regularly searched.

#### Laboratory and small scale experiments

##### 1. Tsetse work

Investigations on the differential effect of insecticides on different species of Glossina were started.

##### 2. Laboratory tsetse culture

Owing to difficulties in obtaining G. palpalis pupae from Uganda it was decided to start a laboratory culture of tsetse flies. A room was constructed and fitted out and G. palpalis, G. morsitans and G. austeni have

been maintained and bred on a small scale. It is now hoped to increase the number of flies.

### 3. Experiments against coffee borer beetles

An investigation was made into the effects of insecticides on Anthonos leuconotus. Endrin and Dieldrin were approximately four times as effective as DDT and chlordane on the basis of "knockdown". There was no differential effect on male and female beetles, and the distribution of a set dosage between a number of tarsi did not alter the effect. There was some indication that susceptibility to insecticides altered towards the end of the adult life of the beetle.

### 4. Experiments against termites

An investigation was carried out to determine whether samples of paper, allegedly treated with DDT, would be eaten by termites when buried in the ground. The "treated" and untreated papers were exposed to the cellulose eating Macrotermes bellicosus and both were consumed to an almost equal extent. Ordinary untreated foolscap was eaten much less rapidly. DDT could not be detected by chemical means on the allegedly treated paper.

### 5. Experiments with chafer grubs

In preliminary experiments BHC at 290 p.p.m. in the soil effected an 80% mortality, chlordane at 234 p.p.m., 40% kill, and Aldrin at 436 p.p.m., 30% kill. All these data relate to an interval of 54 hours.

### 6. Experiments with smoke generators at Magugu.

Two experiments were carried out to investigate how the spacing of smoke generators affected the kill of flies within woodland. The canisters were laid out in staggered rows so as to give a nominal dosage of 2 canisters per acre but in one experiment 5 canisters were placed at each release point whereas in the other each release point had only 2 canisters. Cages of Muscids were placed 250-300 yds. downwind of the first row of canisters. A satisfactory distribution of kill was obtained with 2 canisters at each release point but in the other experiment it was obvious that there were gaps in the distribution.

### 7. Control of ladybirds (Epilachna sp.)

Trials were carried out against a species of Epilachna (Coccinellidae) which sometimes damages young maize and last year caused serious defoliation of full grown plants. Laboratory tests with common available insecticides showed only DDT to be effective. Small scale field trials with a 2½% DDT emulsion at three rates of application gave inconclusive results.

## 8. Grain eating birds

Laboratory tests have shown that 0.5 mg. parathion applied as a 1% benzene solution by micro syringe to the feathers of the back was sufficient to kill the birds after 48 hours. The birds tolerated 5 mg. of malathion. Aldrin, Endrin and Isodrin in petroleum ether solution gave promising results; 2 mg. Aldrin, 1 mg. Endrin and 1 mg. Isodrin all gave a kill in 24 hours.

## Work of the Physics Section

### 1. Assessment of ground machines.

A start has been made on the assessment of ground machines that are likely to be used in East Africa. Preliminary tests have been carried out with the Micron Sprayer, the Swingfog and the TIFA. A Microsol generator has arrived at Arusha and will be tested shortly. Assessment work is to be carried out upon insecticidal applications to cotton and bean plants and the performances of the Swaine Duster, rotary dusters and Four Oaks Ross Knapsack sprayer are to be studied in relation to applications to these crops.

### 2. Assessments of aircraft applications

The Unit is not chartering aircraft at present but it is hoped that an Auster aircraft will shortly be available in East Africa for fundamental work on techniques of application, and for experiments in the control of tsetse flies and other insect pests. In the meantime many assessments have been made with Ansons, Rapides and Austers used by the Desert Locust Control Organisation. Limited tests were carried out on the spraying installation of a demonstration de Havilland Beaver which visited Arusha for a short period in February 1955.

Some experiments were carried out to determine some of the basic data upon which to design equipment for applying granular insecticide from aircraft.

### 3. Laboratory work

A small wind tunnel has been designed for experiments on the pick up by insects of droplets of various sizes.

### 4. Meteorological work

The Unit now maintains a second class meteorological station.

It has been noticed that a high degree of atmospheric turbulence often exists at night in East Africa. Wind speeds are often maximal at about midnight.

## Work of the Chemical Section

### 1. Routine analysis

A total of 3277 samples including coffee bark, sample papers and soils were examined for insecticide content.

### 2. Persistence of Aldrin and Dieldrin in the bark of coffee trees.

Tree stems were sprayed to run off with 0.5% emulsion of the respective insecticide and the insecticide content of the bark determined at varying intervals by the total chlorine method. The results are given in the following tables:-

Persistence of Aldrin in coffee tree bark

| Time after<br>spraying, weeks | Mean Aldrin content, mg/sq. ft. |                        |       |
|-------------------------------|---------------------------------|------------------------|-------|
|                               | Surface<br>washing              | Bark, bast<br>and wood | Total |
| 0                             | 121                             | 106                    | 227   |
| 2                             | 6                               | 60                     | 66    |
| 6                             | 2                               | 32                     | 34    |
| 10                            | 0                               | 31                     | 31    |
| 14                            | 0                               | 23                     | 23    |
| 18                            | 4                               | 19                     | 23    |
| 28                            | 1                               | 18                     | 19    |

The Persistence of Dieldrin content in Coffee Tree Bark

| Time after<br>spraying, weeks | Mean Dieldrin content, mg/sq. ft. |                        |       |
|-------------------------------|-----------------------------------|------------------------|-------|
|                               | Surface<br>washing                | Bark, bast<br>and wood | Total |
| 0                             | 98                                | 132                    | 230   |
| 4                             | 56                                | 74                     | 130   |
| 7                             | 35                                | 60                     | 95    |
| 11                            | 30                                | 90                     | 120   |
| 15                            | 11                                | 40                     | 51    |
| 19                            | 15                                | 25                     | 40    |

The Aldrin content decreased very rapidly and this insecticide is not considered very promising therefore for coffee borer control. Dieldrin was also lost rapidly, in fact the rate of loss was so unexpected that the experiment is to be repeated.

Available evidence indicated the descending order of persistence to be, DDT, Dieldrin, Aldrin.

### 3. Persistence of insecticides in tropical soils

An interim report on the progress of this work was given in the last issue of this journal (P.A.N.S. - A, Vol. 1 No. 2. 55/16).

### 4. The determination of Dieldrin

It has been noted that in the determination of Dieldrin by the total chlorine method a considerable excess of sodium remains after two refluxings. A number of experiments have been carried out to study some of the variables involved in the reaction. It has been found that for amounts of Dieldrin between 4-100 mg. consistent results are obtained using 1 g. sodium and 15 ml. isopropyl alcohol instead of 2.5 g. and 25 ml. respectively as recommended by the W.H.O. method. Furthermore the time of refluxing can be reduced to one hour. There is thus a considerable saving of time and chemicals. The results are summarised in the following table. The Dieldrin used had been crystallised thrice from absolute alcohol, and had a m.p. of 176°C.

Dieldrin recoveries using 1 g. sodium metal, 15 ml.  
isopropyl alcohol; time of refluxing, 1 hour.

| Dieldrin<br>added, mg. | Mean<br>recovery, mg. | Mean<br>% recovery | Number of<br>Replicates | Fiducial<br>Limits of<br>mean (P=.05) |
|------------------------|-----------------------|--------------------|-------------------------|---------------------------------------|
| 4.01                   | 3.97                  | 99.0               | 8                       | ± .03                                 |
| 4.99                   | 4.80                  | 96.2               | 5                       | ± .07                                 |
| 8.02                   | 7.93                  | 98.9               | 5                       | ± .04                                 |
| 12.06                  | 11.69                 | 96.9               | 5                       | ± .43                                 |
| 24.12                  | 23.61                 | 97.9               | 5                       | ± .34                                 |
| 40.55                  | 39.48                 | 97.4               | 5                       | ± .11                                 |
| 60.08                  | 59.24                 | 98.6               | 5                       | ± .54                                 |
| 99.45                  | 98.23                 | 98.8               | 5                       | ± .43                                 |

The mean percentage recovery in the range 4-100 mg. is 98.0, giving a factor for actual/found of 1.02. The regression line has also been calculated, and gives the relationship.

$$\text{Dieldrin present} = 1.013 \times \text{Dieldrin found} + 0.127.$$

As the intercept is small, the error in using the ratio (1.02) instead of the regression line for calculating the amount of Dieldrin present is negligible.

The percentage recovery, using the W.E.O. method, with 40.55 mg. present, was 99.2. Hence, although the use of smaller amounts of sodium may give slightly lower recoveries (and the difference is probably not significant), consistent recoveries are obtained with 1 g. of sodium etc.

The recoveries obtained in the presence of the extracts from 50 sq.in of coffee leaves are given in the following Table.

Dieldrin recoveries using 1 g. sodium metal, 15 ml. isopropyl alcohol; time of refluxing, 1 hour, in the presence of coffee leaf extract.

| Dieldrin added, mg. | Mean Recovery, mg. | Mean % Recovery | Number of Replicates | Fiducial Limits of mean (P = .05) |
|---------------------|--------------------|-----------------|----------------------|-----------------------------------|
| 4.01                | 3.96               | 98.8            | 5                    | ± .07                             |
| 12.06               | 11.65              | 96.6            | 5                    | ± .18                             |
| 24.12               | 23.43              | 97.1            | 5                    | ± .16                             |
| 36.18               | 35.02              | 96.8            | 5                    | ± .16                             |

The reduced quantities of sodium and isopropyl alcohol give consistent results in the range 4-36 mg. Dieldrin (larger quantities were not investigated as it is unlikely that leaf deposits greater than 100 mg./sq. ft. will be applied in practice). Furthermore, there is no significant difference between the percentage recoveries (97.4% in presence of plant extract), indicating that the plant extract does not interfere with the reaction of sodium with Dieldrin.

##### 5. The estimation of wall deposits in house spraying

The Unit is responsible for the estimation of wall deposits in connection with two malaria control schemes namely in the Nandi district of Kenya and the Taveta-Fare district of Tanganyika. Preliminary experiments have, therefore, been made to obtain an estimate of the accuracy with which wall deposits may be determined by means of sample papers. The experiments were done under nearly ideal conditions and the results cannot be applied directly to those obtained under field conditions, nevertheless they provided a useful basis for the design of the sampling procedure.

A wall 8 ft. long by  $6\frac{1}{2}$  ft. high, to which a large number of sample papers had been attached was sprayed with a 2.5% BHC suspension using an Eclipse Leader Junior sprayer fitted with an Eclipse ceramic carbide jet No. 3. Two types of sample paper were attached to the wall in each spraying trial, viz. 5" x 4" squares and 4" x 20" strips of blotting paper. The wall was sprayed with a progressive alternate upward and

downward movement of the lance, with the jet approximately one foot from the wall. The results are summarised in the following Table. In trials 1 - 3 the spraying was done by an experienced field officer, and trials 4 and 5 were done by an African laboratory assistant who had had no previous field experience.

Wall deposits in house sparying

| Sample type 4" x 4" |                                                 |                                            |                         |                                |          |
|---------------------|-------------------------------------------------|--------------------------------------------|-------------------------|--------------------------------|----------|
| Trial               | Mean Deposit<br>per sample<br>paper, mg.<br>BHC | Fiducial<br>limits<br>of mean<br>(P = .05) | % of<br>area<br>sampled | Coefficient<br>of<br>variation | Variance |
| 1                   | 10.2                                            | ± 0.9                                      | 9.8                     | 35.3                           | 12.93    |
| 2                   | 9.6                                             | ± 0.7                                      | 10.0                    | 26.6                           | 6.52     |
| 3                   | 10.9                                            | ± 0.9                                      | 8.8                     | 25.8                           | 9.41     |
| 4                   | 6.9                                             | ± 0.7                                      | 17.9                    | 44.9                           | 18.00    |
| 5                   | 9.0                                             | ± 0.8                                      | 17.5                    | 47.1                           | 11.97    |

| Sample type 4" x 20" |      |       |      |      |       |
|----------------------|------|-------|------|------|-------|
| 1                    | 50.3 | ± 6.4 | 13.9 | 22.6 | 130.2 |
| 2                    | 45.9 | ± 4.2 | 14.9 | 17.3 | 62.73 |
| 3                    | 52.8 | ± 5.0 | 16.0 | 18.9 | 99.38 |
| 4                    | 27.1 | ± 3.3 | 21.2 | 30.4 | 68.17 |
| 5                    | 38.9 | ± 6.2 | 19.2 | 35.5 | 189.6 |

(In the original report the above tables are placed side by side forming one continuous table. In order to reproduce the table on a small page it has been necessary to divide it into two parts.)

From these results the following conclusions have been drawn:-

- (a) The larger type of sample paper will, for equal numbers of sample papers, give a more precise estimate of the mean deposit,
- (b) Hence fewer samples need be analysed of the larger type to obtain a given precision, a saving in laboratory effort.
- (c) There is also less labour involved in the actual sampling in the field.
- (d) The deposits obtained by different spray personnel will probably be more consistent for the larger sample papers than for the smaller ones.

## 6. The persistence of parathion

In view of the proposed use of parathion dust for controlling grain eating weaver birds, experiments are in hand to study the persistence of parathion under East African climatic conditions. Preliminary experiments only have been made so far, but the results obtained will assist in the design of further experiments.

Deposits of parathion (89.8%) on glass plates have been exposed either in the sun or in the shade. The parathion residues were determined by hydrolysing with sodium hydroxide and measuring the colour of the sodium nitrophenoxide produced.

### Results:-

Persistence of parathion deposits on glass plates exposed to sunlight.

| Days exposed | Hours of sunlight | Parathion present, mg. | p-nitrophenol present, mg. | % loss of parathion |
|--------------|-------------------|------------------------|----------------------------|---------------------|
| 0            | 0                 | 12.65                  |                            |                     |
| 1            | 6                 | 9.9                    | -                          | 22                  |
| 2            | 11                | 9.7                    | .02                        | 23                  |
| 4            | 19                | 8.4                    | .03                        | 34                  |
| 11           | 45                | 5.3                    | -                          | 58                  |

Plates with 1.265 mg. dosage showed a loss of 64% after 5 days (22 hr. sunlight) exposure, and the rate of loss appears, therefore, to depend upon the initial dosage - probably the thickness of the film of the deposit is important. It is difficult to decide how much of the loss is due to volatilisation and how much to hydrolysis to p-nitrophenol. For the latter to occur water must be present, and hence if hydrolysis is an important contributory factor the humidity of the air and amount of dew deposition at night will be important.

Persistence of parathion deposits on glass plates in the shade.

| Time of Exposure, days | Trial 1        |        | Trial 2        |        |
|------------------------|----------------|--------|----------------|--------|
|                        | Parathion, mg. | % loss | Parathion, mg. | % loss |
| 0                      | 12.65          | -      | 12.65          | -      |
| 5                      | -              | -      | 0.93           | 26     |
| 8                      | 10.2           | 20     | -              | -      |
| 13                     | -              | -      | 0.94           | 26     |
| 16                     | 9.2            | 27     | -              | -      |

The loss, by volatilisation, of parathion in the shade appears to be a fairly slow process.

#### Experiments with defoliants and arboricides

Accounts of this work are given in the Pesticides Abstracts and News Summaries, Section C - Herbicides (See P.A.N.S. - C, Vol. 1 No. 2)

#### 55/21 WESTERN SOKOTO MALARIA CONTROL PILOT PROJECT: FIRST QUARTERLY REPORT OF THE CHEMIST, APRIL 1955.

D.M. LANGBRIDGE. Birnin Kebbi, via Sokoto, Northern Nigeria.

An insecticides laboratory has been set up in a vacant ward loaned by the Birnin Kebbi hospital, and as could be expected, the scope of the work has of necessity been somewhat limited due to the restricted supplies of apparatus and chemicals.

In spite of these deficiencies however, the amount of work reported and the progress made is very encouraging.

Among the chemical investigations which are reported are the following:

(a) It was found that the Alessandrini method for determining DDT in residual deposits after spraying mud walls was unreliable. The interference was found to be physical rather than chemical, since the presence of finely divided particles of mud with benzene (used for extraction of the nitrated residue) formed an emulsion and prevented complete extraction of the nitrated residue. The use of a few drops of 10% "Teepol" inhibited the formation of this emulsion and complete recovery of the nitrated DDT could be obtained.

(b) The dehydrochlorination of DDT by N. othanolic potassium hydroxide in the presence of acetone has been found to be more convenient if carried out at the normal laboratory temperature of 30°C, than the usual heating under reflux. It is felt that by carrying out the dehydrochlorination at 30°C, the method is more rapid, with less danger of promoting other reactions, and the technique can be employed with water-dispersible powders.

(c) The persistence of residual deposits of DDT on sprayed surfaces has been examined. The samples consisted of varying amounts of dried mud scrapings, taken from a 6" square of surface, and had been taken from Kardi one month after spraying. The results of the analyses are shown in table I.

TABLE I

| <u>Sample</u> | <u>in sample</u> | <u>DDT (mg)</u><br><u>per sq. ft.</u> | <u>% loss of</u><br><u>technical DDT</u> |
|---------------|------------------|---------------------------------------|------------------------------------------|
| 1             | 100              | 400                                   | + 67                                     |
| 2             | 20               | 80                                    | - 70                                     |
| 3             | 60               | 240                                   | - 10                                     |
| 4             | 60               | 240                                   | - 10                                     |

The Alessandrini method of analysis was employed in the absence of equipment and chemicals for more accurate techniques.

From the small number of samples received, it would appear that there is no appreciable loss of DDT during the first month after spraying, although it was uncertain as to what depth in the wall the scrapings were taken, and the result may not indicate the amount of DDT "entomologically" available.

Further samples of scrapings from mud walls taken at Mazarari-Goru were examined, the results being shown in Table II.

The rate of spraying was 267 mg/ft<sup>2</sup> and the age of the deposit on sampling was about 100 days. In this case, the DDT content was estimated by dehydrochlorination at room temperature as described under (b) above.

TABLE II

| <u>Sample</u> | <u>Depth of layer</u><br><u>removed (mm)</u> | <u>Description of</u><br><u>surface</u> | <u>DDT</u><br><u>in sample</u> | <u>per</u><br><u>sq. ft.</u> | <u>%</u><br><u>loss</u> |
|---------------|----------------------------------------------|-----------------------------------------|--------------------------------|------------------------------|-------------------------|
| Blank         | -                                            | -                                       | 0                              | 0                            | -                       |
| 1             | 0.2                                          | White washed                            | 10                             | 40                           | - 85                    |
| 2             | 0.1                                          | Wood soot                               | 5                              | 20                           | - 93                    |
| 3             | 0.1                                          | Wood soot                               | 74                             | 300                          | + 12                    |
| 4             | 0.2                                          | White washed                            | 35                             | 140                          | - 48                    |
| 5             | 0.2                                          | Friable                                 | 20                             | 80                           | - 70                    |

In all but one case there was an appreciable loss of DDT from the surface of the sprayed walls. After 100 days the average deposit remaining was approximately 40% of the initial dosage. There appears to be no noticeable correlation between the type of wall surface and the life of the deposit.

(d) Some experimental work concerned with the formulation of a quick-breaking larvicidal emulsion was undertaken, the most effective, both in spreading and quick-breaking characteristics, was one containing

3 ml. 3% "Surf", 5 ml. 2% DDT in benzene, and 1 ml. glycerol. When used at a dilution of a 1 in 10, 1 ml. of the diluted emulsion was effective in killing mosquito larvae.

(e) 1 ton of a consignment of 50% dieldrin water-dispersible powder on arrival in Nigeria was found to have a lower suspensibility than that required by W.H.O. specification, and the suspensibility deteriorated still further until it became impracticable to use this formulation.

Investigations showed that the addition of surfactants improved the suspensibility and it was subsequently found that the addition of about 5% w/w of "Surf" gave a suspensibility of about 55%; suspensibility of this powder without surfactant was 23.4%.

While the use of "Surf" for this purpose was possible, its use under practical conditions was seriously handicapped by its very low solubility.

To overcome this disadvantage, "Teepol" was tested and it was found that a concentration of about 7% based on the weight of the powder gave a suspensibility of 51.6%. Since "Teepol" is freely soluble in water, no practical difficulties should be encountered in the field.

55/22 FINAL REPORT TO THE COLONIAL INSECTICIDES, FUNGICIDES AND HERBICIDES COMMITTEE, AND THE COLONIAL MEDICAL RESEARCH COMMITTEE ON EXPERIMENTS IN RURAL MALARIA CONTROL IN MALAYA 1948-1952.  
REPORT I.M.R. No. 39. KUALA LUMPUR, DECEMBER, 1954

J.F.B. EDESON, R.H. WHARTON, T. WILSON and J.A. REID.  
Divisions of Malaria Research and Entomology, Institute  
for Medical Research, Federation of Malaya.

#### Author's Synopsis:

This report describes the results of a three-year experiment in the control of rural malaria in Malaya. The experiment was sponsored by the Colonial Insecticides, Fungicides and Herbicides Committee, and by the Colonial Medical Research Committee and was planned and carried out by the staff of the Malaria Research and the Entomological Divisions of the Institute for Medical Research, Federation of Malaya.

Four rice-growing valleys in the State of Negri Sembilan served as the experimental areas, with a combined population of about 4,000 Malays. These valleys are relatively isolated, and the populations are reasonably stable and normally experience a lot of malaria. The valleys are

topographically similar and in each valley the malaria vector is Anopheles maculatus, Malaya's most important mosquito.

Control methods tested in three separate valleys were DDT or BHC (Gammexane) as residual sprays in houses, and the weekly distribution of proguanil (Paludrine) as a suppressive drug; the fourth valley was left unprotected as a comparison area. The insecticides were applied as wettable powders in doses of 200 mg. DDT or 40 mg. gamma isomer of BHC per sq. foot at intervals of six months; proguanil was issued in a weekly dose of 100 mg. per head for everyone in that valley except infants.

Preliminary investigations started in 1948, and control work a year later; observations then continued for another three years, until late in 1952. At the end of the experiment the houses in each of the four valleys were sprayed with DDT, which had become preferred method of control; responsibility for future control was then assumed by the Negri Sembilan Medical Department as a part of a larger scheme for the control of rural malaria.

Full details of the effects of the control work on malaria and on mosquitoes are given in the body of the report, and in numerous tables in the appendix; what follows here is a much condensed summary.

- (i) By each method of assessment, the comparison area had a consistently higher incidence of malaria than had any of the protected areas throughout the three-year control period.
- (ii) Although malaria was reduced by each of the control methods it was far from being eradicated. Interpretation of the periodic survey results was complicated by what was apparently a "natural" fall in the incidence of quartan malaria in all areas; at these surveys the main reduction in the protected areas compared with the unprotected one was in the number of falciparum infections. The primary malaria infection rate in infants and the proved malaria rate in dispensary outpatients were each some two and half times greater in the unprotected area than in any of the protected ones over the three year control period.
- (iii) Proguanil had a more rapid effect on spleen and parasite rates than had the insecticides, and after three years the end-results with proguanil were still slightly better. But the regular distribution of the drug was difficult to ensure; and supervision of administration was impossible; for this reason house-spraying with a residual insecticide was preferred for general use, and at the doses and intervals used DDT appeared to be slightly better than BHC.

- (iv) The reduction of malaria had no perceptible effect on the vital statistics, the general health, or the economic conditions of these Malay kampong dwellers.
- (v) There was no indication of any change in the overall mosquito population as a result of house-spraying. Some figures suggested that the numbers of adult A. maculatus may have been slightly reduced in the sprayed areas, but there was nothing to show that any other species was affected. After three years thorough house-spraying with comparatively high doses of DDT or BHC there was not the slightest sign that A. maculatus would ever be eradicated by this means. It is relevant to add that this species appears to be the Malayan vector of malaria most susceptible to the action of these insecticides.

It is concluded that these results are compatible with what is known about the feeding preferences and resting habits of the principal Malayan vector, A. maculatus.

House-spraying with residual insecticides will be the only practicable method of controlling endemic malaria in rural areas, but it cannot replace antilarval measures for town areas, nor suppressive drugs where a rapid effect is required. Eradication of either mosquitoes or malaria by house spraying alone is not to be expected. This means that spraying programmes, once started, must be continued indefinitely.

We may add that residual spraying as a public health measure, using mainly DDT emulsion, has now been extended to protect over half a million people in rural areas throughout Malaya. The methods employed are based on the recommendations that we have been able to make as a direct result on the experiment described in this report.

Postscript. We have had a small confirmation of our results from the effects of routine DDT spraying in the Rokan valley by the Negri Sembilan Medical Department. Parasite and spleen rates in the school children of this valley remained high over the four years 1948-1952, and during this time there was no malaria control or special medical attention of any sort in the area. DDT spraying commenced in October 1952, and a survey in August 1954 showed a big reduction in the parasite and spleen rates.

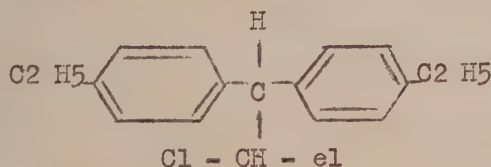
E.M. SWISHER. Rohm & Haas Co. Pa. Proceedings of the  
Chemical Specialties Manufacturers Association Inc., Dec. 1954.

Following the advent of DDT, a number of analogues were investigated with the object of discovering other insecticides of this class which might offer worthwhile possibilities.

As a result, Rhothane or TDE (dichloro diphenyl dichloroethane) and Methoxychlor (dimethoxy diphenyl trichloroethane) have found wide use, the former in agricultural applications particularly in the control of certain insects which DDT did not adequately control, and the latter in dairy sprays, aerosols, and various agricultural uses.

Another analogue, Perthane is now commercially available, at a current cost of 60 cents a pound for the technical material.

Chemically, Perthane is diethyl diphenyl dichloroethane with the following structure,



Thus Perthane may be regarded as the ethyl analogue of Rhothane.

The technical grade has a setting point of 40°C, and is a soft whitish granular material, readily soluble in a wide range of aromatic and paraffinic solvents, including kerosene. It can be readily formulated into oil-based sprays, emulsifiable concentrates, wettable powders or dusts, and is compatible with all commonly used insecticides and fungicides.

Analytical methods for Perthane have proved to be a difficulty. For production purposes, total chlorine analysis is adequate, but is of no use if other chlorine-containing materials interfere.

For residue analyses, the Schechter-Haller method as used for DDT is not applicable. However a spectrophotometric procedure has now been produced which is claimed to be accurate within 0.05 ppm and with various modifications this method can be used to detect residues on various materials.

This method, devised by Dr. E.L. Stanley and Francis Jackson of the Rohm & Haas Co., is available on request.

Extensive studies on the toxicology of Perthane have been conducted at the University of Virginia Medical College, and have shown that the oral LD<sub>50</sub> for Perthane in corn oil for rats is approximately 8,170 mg/kg., and for mice, 9,340 mg/kg. Intravenous LD<sub>50</sub> for rats is 73 mg/kg. and for mice 173 mg/kg. The percutaneous toxicity of Perthane was studied by daily applications of 1 ml. and 3 mls. per kilogram of body weight of a 30% solution of Perthane in dimethylphthalate. Tests run for 13 weeks with no discernible adverse effects, gross or microscopic, attributable to the treatment.

The addition of Perthane to the diet of dogs at 100, 1000 and 5000 ppm. for a period of one year caused no adverse effects at 100 ppm, non-fatal adrenal cortical atrophy at 1000 ppm, and fatal adrenal cortical atrophy at 5000 ppm. The tendency for Perthane to accumulate in fatty tissue is considered to be slight as a result of feeding tests on rats fed with radio-active C 14 labelled material.

In tests designed to measure the possibilities of accumulation of Perthane in the milk of dairy animals sprayed with this insecticide, it was shown that cows sprayed daily with 1 ounce of 0.5% Perthane in kerosene were found to have residues of Perthane in the milk not exceeding 0.15 ppm. after 21 days of continuous spraying. After spraying was discontinued, the Perthane content in the milk dropped to about 0.1 ppm. and after 5 days to only trace levels.

This does seem to point to the fact that Perthane can be considered for dairy applications, although the Food & Drug Administration, U.S.D.A. have not yet ruled on this point.

Field and laboratory studies have shown that Perthane dispersible powder and emulsion concentrates are effective for the control of horn flies and lice, especially sheep keds, and cattle and goat lice.

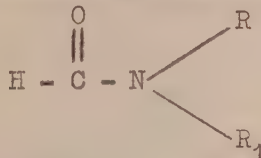
Against a strain of resistant house flies, Perthane was found to have an LD<sub>50</sub> of 2.7 ug per fly, whereas DDT at 120 ug per fly failed to cause any mortality. Against non-resistant flies, DDT had an LD<sub>50</sub> of 0.6 ug per fly, and Perthane 1.5 ug per fly. From these laboratory tests, it would appear that Perthane was not as effective as DDT, against non-resistant flies, but appeared to be most effective against resistant flies where DDT failed completely.

In view of its low toxicity, Perthane should find special application for household purposes, in addition to dairy uses.

55/24 PRELIMINARY TESTS OF SOME N-SUBSTITUTED FORMAMIDES AS  
INSECTICIDES AND MITICIDES

S.I. GERTLER, A.P. YERINGTON. United States Department  
of Agriculture. ARS-33-1. Sept. 1954.

Test results are reported on some thirty N-substituted formamides. These compounds may be represented by the general formula,



where R or R<sub>1</sub> is a hydrogen, alkyl, cycloalkyl, aryl, substituted aryl, or cyclic group, and were prepared by reacting various amines with formic acid under suitable conditions.

For the purposes of these tests, the following insect species were used: Armyworm (Pseudaletia unipuncta (Haw.)), Bean weevil (Acanthoscelides obtectus (Say)), Large milkweed bug (Oncopeltus fasciatus (Dall.)), Pea aphid (Macrosiphum pisi (Harris)), Citrus red mite (Metatetranychus citri (McG.)), Two-spotted spider mite (Tetranychus bimaculatus (Harvey)).

In tests against armyworms, o-chloro formanilide was the most toxic at 5% and 1% concentrations; fumigation tests against the larvae of the bean weevil showed that N, N-dipropyl formamide, and the corresponding dibutyl and diethyl formamides were the most effective, after fumigation with 0.2 g. of the test compound for 21-24 days in 100 ml. petri dishes.

The higher monoalkyl formamides showed the highest toxicity against the nymphs of the large milkweed bug at concentrations of 5% and 1%. Adult pea aphids were most susceptible to 5% concentration of the higher members of the formamide series, such as dioctyl, dipentyl and octyl, which also showed some toxicity at 1%.

N-N-dibenzyl formamide gave 100% kill of adult citrus red mite at 0.1%, other compounds being practically all toxic at 5%.

The most toxic compounds against the two-spotted spider mite were the straight-chain monoalkyl substituted ones above heptyl, such as N,N-dipentyl and N-octyl-formamide, as well as the straight-chain dialkyl substituted compounds above dibutyl. The lower members and the branched members of the series were distinctly less effective.

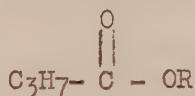
In all the tests, N,N-dibutyl formamide and N,N-dipentyl formamide gave 100% kill of three insects and one mite at 5% concentration. N,N-diethyl formamide was also effective against three insects, but somewhat less effective as a miticide. Six compounds were effective against two insects and a mite - N-Octyl formamide, N,N-dioctyl formamide, N,N-dibenzyl formamide, o-chloro-formamide, N-ethyl formanilide, and O-iso-pentyl formanilide. N,N-dipropyl-formamide, and N-heptyl formamide gave high kill of two insects. N-tert-butyl-formamide, N-hexyl formamide, N-phenethyl-formamide, and N-pentyl formamide were effective against one insect and one mite.

## 55/25 PRELIMINARY TESTS OF SOME PHENOL ESTERS OF BUTYRIC ACID

S.I. GERTLER, A.P. YERINGTON. United States Department of Agriculture. E-877. May, 1954.

Screening tests with 34 phenol esters of butyric acid used as insecticides are reported in this bulletin.

These compounds have the following general formula:-



where R is a phenyl, substituted phenyl, or naphthyl group, and were prepared by reacting the phenol with butyric anhydride under suitable conditions.

The following species of insects were used: Armyworm (Pseudaletia unipuncta (Haw.)), Large Milkweed bug (Oncopeltus fasciatus (Dall.)), Pea Aphid (Macrosiphum pisi (Harris)). One species of mite was used viz:, Two-spotted Spider Mite (Tetranychus bimaculatus (Harvey)).

Against the larvae of the armyworm, the pentachlorophenol ester was the most toxic, the toxicity falling off with the less chlorinated esters. The 4,6-dinitro-o-cresol ester also appeared to be quite toxic, but to a lesser degree than the highly chlorinated phenol esters. In general, the use of mixed halogen and alkyl substituents tended to cause a decrease in kill, and this was equally true of the addition of aromatic or cycloaliphatic groups to the ring.

Tested against the fourth-instar nymphs of the large milkweed bug, the most toxic compounds were the 2,4-dinitrophenol and 4,6-dinitro-o-cresol esters; the o-nitro-compound was considerably less effective,

while the chlorinated phenol esters behaved in almost the opposite way from that with the armyworm.

A mixed pattern of toxicity against adult pea aphids was obtained, although the dinitro derivatives were still the most toxic, with the p-nitrophenol ester being slightly less so. The most effective were the trichloro, tetrachloro and tribromophenol esters, although high kills were also obtained with the esters of the naphthols and cyclohexyl phenols and some mixed substituents with halogen tert-betyl groups.

p-nonylphenol butyrate was among the more toxic compounds, and showed a greater kill than the lower aliphatic substituents.

All the compounds tested against the two-spotted spider mite showed 100% kill at 5% concentration, and more than half showed at least a 90% kill at 1%. The pentachloro, tetrachloro and the two dinitro substituted phenols seemed to be quite effective miticides.

Of all the compounds tested, 4,6-dinitro-o-cresol butyrate was the most toxic, and showed a high kill on all test insects at 1% concentration, while being a good miticide at 0.05%. The 2,4-dinitrophenol ester was also effective against all four insects, although only moderately toxic to the armyworm.

It is evident that most of the compounds demonstrated no consistent effect on all the test animals. Indeed, in some compounds an almost complete reversal was noted in the relative effectiveness of the compounds to different test species.

#### 55/26 A METHOD OF DETERMINING PARTICLE SIZE OF LIQUIFIED GAS AEROSOLS

A.H. YEOMANS. United States Department of Agriculture.  
ARS-33-5. March 1955.

The method employs a micro-counting technique of the particles deposited on a glass slide. The slide (3 x 1") is coated with an oleophobic substance such as Dri-film 9987 (General Electric Co.). The method of deposition depends on their size, and for aerosols in which all the particles are less than 50 microns in diameter but the mass median diameter is more than 8 microns, an impactor is used. This consists of a ventilating fan which draws the aerosol through a tube 20" in diameter and 60" long.

The aerosol is released at the centre of one end of this tube so that it carries toward the fan at the other end. About 42" from the release point and 18" in front of the fan, the slide is revolved on a 4" radius at 400 r.p.m.

This is accomplished by means of a counter-balanced holder for the slide turned by a variable speed stirrer motor. This slide holder was constructed by cutting off two blades from a fan with blades 8" in diameter and then flattening the remaining two blades.

On the end of one blade a copper slide holder was soldered, three edges of which were bent  $1/16$ " over the face of the slide, so that the slide could be pushed in easily, and so that the 1" open end of the holder faced the release point of the aerosol.

The slide revolved counterclockwise so that its exposed face was in the direction of rotation. The outside 3" edge was located ahead of the bottom edge, making a 25° angle between the face of the slide and the 4" turning radius, in order to minimize sliding of the droplets due to centrifugal action.

The fan blade was cut in the centre to a depth of  $\frac{1}{2}$ " and the forward piece bent down before the holder was soldered so that the slide had a clear path to collect particles. A weight was soldered on the end of the other fan blade to balance the slide holder and slide.

It was found best to expose the slide long enough for about 0.3-0.5 g to be released. This was obtained by attaching the variable speed motor with the revolving slide on a swivel and lowering it from a well in the side of the tube down into the stream of aerosol.

The swivel was constructed of  $\frac{1}{4}$ " pipe fastened to the inside of the 20" tube and serving as the axis. It was placed on the right side of the tube so that its centre line was  $3\frac{1}{2}$ " below the horizontal centre line of the tube, 1" inside the wall of the tube, with one end  $10\frac{1}{2}$ " from the fan. On this pipe axis a tee was attached loosely enough so that it could be turned. On one side of this tee two pipes 4" long joined by a 90° elbow were attached. To the top pipe, which was parallel to the axis of the tube, the variable speed motor was attached, and on the other side of the tee a handle for revolving it.

After the aerosol had been deposited on the slide, it was placed under the microscope, and the particles measured with an eyepiece micrometer having 50 divisions, each division equal to 15.4 microns; a 100-power microscope is best for particles of aerosol size. The diameter is measured on the slide and is then corrected for the spread that has taken place so that the diameter of the original sphere can be determined. At least 200 particles should be measured. All the particles from one edge of the slide to the other are counted as the slide is moved by the mechanical stage.

Details are given showing the methods employed for determining the median particle diameter, and it is emphasised that the particle size of a liquefied gas aerosol should be reported not only by mass median diameter but also by the accumulative percentage for each 5 microns in diameter up to 50 microns.

55/27 SCREENING PROCEDURE FOR CANDIDATE FUMIGANTS FOR STORED GRAIN AND GRAIN PRODUCTS.

N.M. DENNIS, W.K. WHITNEY. Stored-Product Insects Section,  
United States Department of Agriculture E.-878. May, 1954.

This bulletin describes a screening procedure which is designed to establish the minimum lethal dosage of new compounds, both in space and in commodities, and their performance under various conditions. Thus, the candidate fumigant can be evaluated in the laboratory at normal atmospheric pressure.

Before biological tests are commenced, the candidate compound is studied from the point of view of its physical and chemical properties. Many compounds may be eliminated because of objectionable odour, inflammability, corrosiveness to metal, effects on the viability of seed grain, etc.

The confused flour beetle (Tribolium confusum Duv.) and the rice weevil (Sitophilus oryzae (L.)) are used to determine the comparative toxicity of the fumigant under investigation.

Tests are carried out in empty glass flasks and empty glass cylinders to determine the fumigant's toxicity in space, and then in similar cylinders filled with a commodity. Before being exposed in these containers, the insects are placed in 45 mesh screen cages  $\frac{1}{2}$ " in diameter and  $2\frac{1}{2}$ " long, 30 insects to a cage.

The fumigant is first tested in a 20 litre flask. A glass tube passing through a rubber stopper is connected to a glass stopcock outside the flask. Two cages of insects of each species separately are suspended in the centre of the flask. A partial vacuum (20 inches) is made in the flask to facilitate introduction of the fumigant and a measured dose of liquid fumigant in a pipette is then held over the end of the glass tube extending from the stopcock, and introduced by opening the stopcock and allowing the vacuum to draw the fumigant into the flask.

After an exposure of 20 hours the insects are examined for mortality; a check observation on possible recovery is made 5 days later. These tests are run in 3 to 5 replicates and repeated until the minimum lethal dose is determined.

In the next series of tests a glass cylinder  $7\frac{7}{8}$ " in diameter and 6 feet high is used. This cylinder consists of sections 1 foot high, taped together with 1" plastic tape, the ends being closed with disks of tempered Masonite impregnated with paraffin. Cages containing the test insects are suspended within the cylinder at three levels, viz. 1" from the bottom, in the centre, and 1" from the top. A plastic gas-sampling

tube is placed beside each cage, and passed to the outside through a hole in the top Masonite disk. Through another hole in this disk the liquid fumigant is introduced into a flat-bottomed dish suspended at the top of the cylinder. Gas samples are withdrawn at intervals to determine the distribution and concentration of the fumigant.

The behaviour of the fumigant in cylinders filled with wheat or other commodities is now studied.

In these tests the performance of the fumigant may be observed under several conditions (1) with the cylinder completely sealed, (2) with the top open and the bottom sealed, (3) with the top sealed and a plastic tube sealed into the bottom to provide drainage, and (4) with the top open and the drainage tube in the bottom.

The fumigant may be re-circulated by means of a blower, if desired. This closed system may be used with either empty or filled cylinders. In this way, the minimum lethal dosage and the dispersion of the gas may be ascertained.

All the fumigation tests are conducted at a temperature of 80°F. which is thermostatically maintained.

#### 55/28 INSECTICIDES FOR USE IN LIVESTOCK-DIPPING VATS

Prepared by the Section Investigating Insects Affecting Man and Animals, United States Department of Agriculture. E-880.  
June, 1954.

The insecticides most widely used in livestock-dipping vats in the Southern United States are toxaphene and a mixture of DDT and BHC.

Originally the Department had not recommended emulsion dips of these insecticides because early experience showed that they were hazardous. During the last few years, however, commercial formulations have been greatly improved, and it is now possible for cattle to be safely dipped in these formulations.

During the seasons of 1951, 1952 and 1953 the performance of commercially formulated insecticides in dipping vats was closely observed by the workers of the Kerrville Texas Laboratory.

Emulsions made with two commercially formulated toxaphene emulsifiable concentrates performed successfully. In addition, the co-operating companies made available the results of their own field experiments, and

it was concluded from these studies that the physical characteristics of dips from the best commercial formulations change during 6 months' use.

In fresh mixtures, the oil phase is practically colloidal, and very few particles can be observed at 960 x magnification. As the dips age these colloidal particles coalesce to form visible droplets, and then these minute droplets fuse to produce still larger droplets. As the particles increase in size, they are more readily taken out by the hair of the cattle swimming through the vat. In freshly mixed dips containing 0.5% of toxaphene cattle received deposits averaging about 1% of the weight of the hair. At the end of the dipping season, although the concentration of insecticide had been maintained through the addition of fresh concentrate and water, the deposits on the hair increased 50% to about 1.5% of the weight of the hair. This is considered to be the maximum deposit that can be safely tolerated by the most susceptible farm animals.

A technique for evaluating the emulsion stability of the diluted dips was worked out following experimental work at the Orlando laboratory. The apparatus consists of an emulsibility tube 22 mm outside diameter, 4 feet long, joined to a 15 ml. conical centrifuge tube, the mouth of the centrifuge tube fitting flush with the end of the 4 foot tube. The centrifuge tube is graduated in 0.1 ml. divisions for making the sedimentation readings. A tipless pipette, prepared by cutting off the tapered tip below the 5 ml. mark and grinding the end to a smooth flat surface, is used for introducing the concentrate into the emulsibility tube.

Three types of test waters were used, viz. distilled water, a synthetic soft water, with a hardness of 20 p.p.m. as calcium carbonate, and a synthetic hard water, hardness 500 p.p.m. as calcium carbonate.

The emulsibility tube, held vertically in a rack, is filled with about 350 ml. of the test water. Sufficient of the emulsion concentrate is added to the tube to give a 0.5% toxaphene emulsion. The rapidity and degree of desintegration of the concentrate is noted, and observations for bottom creaming or breaking of the emulsion are made after 1 hour, 24 hours, and 30 days. The test is conducted at  $80^{\circ}\pm 5^{\circ}\text{F.}$ , the insecticide concentrate and test waters being at room temperature.

The insecticide should disperse spontaneously in all test waters, with the oil phase breaking up as it sinks. No oil droplets should reach the bottom of the tube. After 1 hour's standing there should be no more than a trace of bottom cream, and after 24 hours' standing there should be no more than 0.2 ml. of bottom cream, and this should re-suspend completely on one inversion of the tube. The tube should be stoppered and left to stand for 30 days. At that time the creaming should not be appreciably greater than after the first 24 hours.

Four commercial toxaphene dispersible powders, each containing 40% toxaphene were studied in field and laboratory tests, and were compared with a combination DDT-BHC dispersible powder, which is widely used for dipping vats.

All four toxaphene powders gave satisfactory insect control, re-suspended normally, and did not cause excessive deposits of toxaphene on the hair of cattle dipped during the 6 months' season.

It is considered that the average particle size should not greatly exceed 7 microns and at least 98% of the powder should pass a 325-mesh sieve.

The following laboratory test for a toxaphene dispersible powder was used: 3.2 litres of tap water at room temperature was put into a 1 gallon glass jug. An amount of dispersible powder equivalent to 16 g. of actual toxaphene was added, by pouring the powder onto the surface of the water. Without agitation, all the powder should wet out and sink below the surface within 10 minutes. The powder should appear well dispersed after 7 inversions of the jug. There should be no appreciable settling during the first 5 minutes after inversion and only about  $\frac{1}{2}$ " of sediment after 1 hour. The powder should not cake on standing overnight, but should re-suspend as easily as it did 1 hour after mixing.

Some general advice on the use of insecticides in dipping vats is given. Thus, toxaphene either in an emulsifiable concentrate or as a dispersible powder, should be employed at 0.5%. DDT in dispersible powder form should also be used at a concentration of 0.5%. For control of lice and horn flies DDT alone is satisfactory, but if animals are being dipped for tick control there should be added enough BHC dispersible powder to give 0.025 to 0.03% of the gamma isomer.

The dipping vat should be thoroughly cleaned before charging. After filling to a measured line with water, the exact amount of insecticide is added. An emulsion concentrate should be added by pouring uniformly along the full length of the vat, while a dispersible powder should be scattered uniformly over the surface of the water. Mixing is accomplished by dragging a bucket on a rope through the vat several times.

Dipping should follow immediately, and each time the vat is used for subsequent dippings, remixing is carried out in the same way.

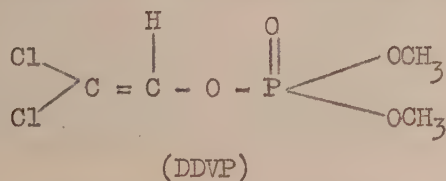
#### 55/29 DDVP - A NEW PHOSPHORUS INSECTICIDE

Technology Branch: Summary of Investigation No. 7.  
Communicable Disease Centre, Georgia. July-Dec. 1954.

During the course of screening various insecticides for their vapour toxicities towards houseflies, a highly toxic impurity was discovered in one of the organic phosphorus compounds under test, and this new compound

has been designated as DDVP, O,O-dimethyl 2,2-dichloro-vinyl phosphate.

This compound was isolated from a commercial preparation called "Dipterex" supplied by Chemagro Corporation, and originally known as Bayer L-13/59, which is chemically, O,O-dimethyl 2,2,2-trichloro-1-hydroxyethyl phosphonate. It was found that by subjecting this compound to alkaline hydrolysis at room temperature, an oily insoluble material settled out, which was subsequently considered to be O,O-dimethyl 2,2-dichlorovinyl phosphate, with the following structure:



DDVP appears to be equivalent to parathion as regards toxicity to houseflies as may be seen from the accompanying Table of toxicities.

---

Twenty-four hour Mortalities (Percent) of 3 day old Female Musca domestica after Topical Application of various Compounds.

---

| Insecticide | Micrograms/fly | 24 hour mortality<br>(per cent) |
|-------------|----------------|---------------------------------|
| DDVP        | 0.025          | 22                              |
|             | 0.030          | 46                              |
|             | 0.035          | 82                              |
| Parathion   | 0.0278         | 67                              |
|             | 0.0342         | 100                             |
| L-13/59     | 0.275          | 40                              |
|             | 0.550          | 98                              |

---

Mammalian toxicity tests against white rats indicate that DDVP is from 5 to 10 times less toxic than parathion to higher animals. When administered by the dermal route, DDVP was found to be approximately one fifth as toxic as parathion.

Among significant developments which are reported are the following:

Repellents. An improved method for the determination of the presence or absence of synergistic or extending action between repellents has been developed. Tests were carried out against Aedes aegypti with N,N-diethyl-toluamide and 2-ethyl-1,3-hexanediol at concentrations ranging from 12.5% to 50% in ethanol. Protection times obtained were used to compute concentration - protection time regression lines, from which the effective period of any concentration could be obtained. Thus, concentrations required for complete protection for 200 minutes were 22.38% for N,N-diethyltoluamide and 52.10% for 2-ethyl-1,3-hexanediol.

A further series of tests were carried out against A. aegypti with these two compounds alone and mixture at ratios of 1:3, 1:1 and 3:1 as 50% ethanol solutions. The 1:3 ratio mixture gave a protection time of 252 minutes, the 1:1 ratio gave a protection time of 312 minutes, and the 3:1 ratio gave a protection time of 372 minutes. It was concluded that there was no synergism between the repellents, as the protection time of each mixture was very close to that computed from the concentration.

Louse Control. Against resistant body lice, the effectiveness of DDT was not improved by the addition of two synergists, which have been reported to increase its effectiveness against resistant flies.

The synergists, DMC, 4,4'-dichloro- $\alpha$ -methylbenzhydrol and MR60, chloro bis (p-chlorophenyl) methane, were used at a ratio of one part to 5 parts of DDT.

A concentration of 10% DDT and 2% DMC caused an 18% mortality against the highly resistant colony. Against the moderately resistant colony there was no significant increase in the effectiveness of DDT by the addition of either DMC or MR60. There was also no increase in effectiveness of DDT against the regular colony lice by the addition of either synergist. No definite conclusions have been reached regarding any similarities of the processes of resistance between body lice and houseflies.

Control of House Flies. The residual effectiveness of DDVP (2,2-dichloro-vinyl dimethyl ester of phosphoric acid) was increased by the addition of Aroclor 5460. Applications were made to unfinished and varnished plywood panels as sprays in acetone, at the rate of 25 mg. DDVP and 100 mg. Aroclor 5460 per square foot.

A 30 minute exposure to DDVP alone, produced 100% kill of flies on panels aged for 1 and 7 days, a 60 minute exposure being necessary to give 100% kill after 14 and 28 days, whereas the mixture of DDVP and Aroclor 5460 killed 100% of the flies in a 30 minute exposure after ageing for 28 days.

There was apparently no difference between the results on unfinished and varnished plywood.

It is emphasised that field use of materials containing Aroclor mixtures may involve special formulation problem.

Control of Fleas and Bed Bugs. Several phosphorus insecticides were more effective than DDT as residual treatments against normal and resistant bed bugs, and were also highly effective against cat fleas.

63 toxicants, which had been outstanding against body lice and mosquito larvae were tested as residual treatments at 200 mg. per square foot on plywood panels against bed bugs of the regular colony and the resistant Korean colony. O-(2-chloro-4-nitrophenyl) O,O-dimethyl ester of phosphorothioic acid, Bayer L 13/59 (O,O-dimethyl 2,2,2-trichloro-1-hydroxyethyl phosphonate), O-(1-carbethoxyethyl) O,O-diethyl ester of phosphorothioic acid, and the diethyl 1,2,2,2-tetrachloroethyl ester of phosphoric acid produced 90 to 100% kill of bed bugs of both colonies in 24 hours, DDT killing only 80% of the regular colony and none of the Korean colony.

These phosphorus compounds were outstanding in tests against cat fleas, causing 100% mortality of fleas 24 hours after a 2 hour exposure on panels that had aged for one month.

Control of Roaches, Ants and Firebrats. Dieldrin sprays at 0.5% were equal or superior to chlordane at 2% against normal German and American cockroaches, ants and firebrats.

Against German cockroaches, the dieldrin was 100% effective for 2 weeks and the chlordane for 1 week on painted plywood; on unpainted plywood, the dieldrin was 100% effective for 16 weeks and the chlordane for 4 weeks.

Against American cockroaches, the dieldrin was 95% to 100% effective for 8 weeks on unpainted plywood, whereas the chlordane was only 85% effective. On painted plywood, the dieldrin was 85% effective, and the chlordane 10% after one week.

Against firebrats, dieldrin was 80 to 100% effective for 8 weeks on unpainted plywood, but only as a fresh treatment on painted plywood.

Chlordane at 2% was 80% effective as a fresh treatment on unpainted plywood and ineffective on painted plywood.

Laboratory tests showed that there was little practical advantage to be gained by adding DDT to chlordane as a residual treatment for cockroaches.

Mosquito Larvicides. Aqueous solutions of Bayer L 13/59 (O,O-dimethyl 2,2,2-trichloro-1-hydroxyethyl phosphonate) exposed to sunlight for 4 weeks, showed no loss in toxicity to larvae of Anopheles quadrimaculatus, and the same was true of Shell OS-2046 (1-carbomethoxy-1-propen-2-yl dimethyl ester of phosphoric acid).

In field tests against Mansonia larvae, granular larvicides containing EPN or dieldrin were effective. EPN granules at 0.25 and 0.1 lb. per acre caused reductions of 97% to 99% within 24 hours; dieldrin granules at 0.1 lb. per acre produced a low initial kill but were 92% to 95% effective after 1 to 3 weeks. Applied as emulsions, schradan and systox were not effective at dosages up to 0.25 lb. per acre.

Protection of Woollens. Almost complete protection of woollen cloth against fabric insect damage is being obtained with the DDT-impregnation treatment, despite the fact that the treated cloth has been continually exposed for 7 years to a very heavy infestation.

# NEWS ITEMS

(xxvii) THE EMPIRE COTTON GROWING CORPORATION. PROGRESS REPORTS FROM EXPERIMENT STATIONS. SEASON 1953-54

COTTON RESEARCH STATION, GATOOMA, SOUTHERN RHODESIA

Because of past experience of heavy insect attacks, it was arranged to spray all the breeding material. The only unsprayed material on the Station was a commercial bulk of 9L34 which was not reaped owing to its very poor yield of about 100 lb. per acre.

All liquid insecticides except parathion were applied with Mysto knapsack sprayers. Leo Colibri sprayers were used for parathion as they are less likely to leak. The duster used was an Eurova bellows-type, which did not prove satisfactory, especially with the low rate of application.

Despite the application of insecticides, yields were very variable and staining percentages generally high.

## SUMMARISED RESULTS FROM AN INSECTICIDE TRIAL, 1953-54

Randomised block with four replications each of fifteen treatments plus control. Plot size 90 feet x 19 feet, separated by six rows of sorghum. Replications separated by 10 yard paths.

Note: Spraying commenced on 13/1/54: Main flowering period commenced on about the 23rd January.

| Treatment No. | Treatments                             |     |     |     |     |     |     |     |     |     |     |     | Total S/C Yield Lb./ Acre | % Stained | Profit increase over control | Cost of insecticide per acre |
|---------------|----------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---------------------------|-----------|------------------------------|------------------------------|
|               | Number of Days from Start of Treatment |     |     |     |     |     |     |     |     |     |     |     |                           |           |                              |                              |
|               | 0                                      | 7   | 17  | 24  | 38  | 39  | 45  | 49  | 52  | 59  | 59  | 69  |                           |           |                              |                              |
| 12            | Pa                                     | Pa  | Pa  | P   |     | PPa |     | PPa |     |     | PPa | PPa | 616                       | 29.7      | 181/-                        | 176/-                        |
| 4             | P                                      | P   | P   | P   |     | PL  |     | PL  |     |     | FL  | FL  | 523                       | 34.2      | 59/-                         | 233/-                        |
| 2             | WP                                     | WP  | WP  | WP  |     | WP  |     | WP  |     |     | WP  | WP  | 481                       | 34.0      | 62/-                         | 192/-                        |
| 3             | PL                                     | FL  | FL  | PL  |     | PL  |     | FL  |     |     | FL  | FL  | 464                       | 37.7      | - 82/-                       | 317/-                        |
| 11            | Pa                                     | Pa  | Pa  | P   |     | PL  |     | PL  |     |     | PL  | PL  | 456                       | 39.6      | 9/-                          | 215/-                        |
| 5             |                                        |     |     | P   |     | FL  |     | PL  |     |     | PL  | PL  | 452                       | 38.7      | 51/-                         | 174/-                        |
| 1             | D                                      | D   | D   | D   |     | D   |     | D   |     |     | D   | D   | 444                       | 36.9      | 72/-                         | 151/-                        |
| 8             |                                        |     |     | P   |     | FL  |     | PL  |     |     | PL  |     | 389                       | 38.9      | 49/-                         | 135/-                        |
| 10            | T                                      | T   | T   | T   |     | T   |     | T   |     |     | T   | T   | 288                       | 34.8      | 19/-                         | 98/-                         |
| 9             |                                        |     |     | P   |     | PL  |     | PL  |     |     |     |     | 239                       | 43.3      | - 1/-                        | 95/-                         |
| 6             |                                        |     |     |     |     | PL  |     | PL  |     |     | PL  | PL  | 234                       | 46.9      | - 82/-                       | 158/-                        |
| 15            | D*                                     | D*  | D*  | D*  | D*  |     | D*  |     | D*  | D*  |     |     | 233                       | 48.6      | 13/-                         | 61/-                         |
| 7             |                                        |     |     |     |     |     |     | PL  |     |     | PL  | PL  | 216                       | 44.5      | - 50/-                       | 119/-                        |
| 13            |                                        | PL* | PL* | PL* | PL* |     | PL* |     | PL* | PL* |     |     | 186                       | 57.4      | - 69/-                       | 107/-                        |
| 14            | B*                                     | B*  | B*  | B*  | B*  |     | B*  |     | B*  | B*  |     |     | 160                       | 50.5      | -297/-                       | 377/-                        |
| 16            | Control                                |     |     |     |     |     |     |     |     |     |     |     | 110                       | 54.2      |                              |                              |

Key to Treatments:

P = Psylortox DDT; Pa = parathion; T = toxaphene; L = Lindacide;  
B = DDT/BHC bait; WP = DDT/BHC wettable powder; D = DDT/BHC dust.

\*Low rate of application - 0.6 lb. DDT+0.18 lb. gamma BHC in dust or spray from per acre.

Other treatments at the rate of  $1\frac{1}{2}$  lb. active DDT +  $\frac{1}{2}$  lb. EHC per acre. Parathion and toxaphene were applied at recommended rates. Profit increase over control = cash value of cotton from treatment less the cost of insecticide and cash value of cotton from control. For significance at  $P = 0.05$  difference in yield required = 227 lb. per acre.

The main results of the trial were:-

1. Eight of the fifteen treatments yielded significantly better than the control plots. Of these seven showed a profit increase. The loss on the eighth treatment was due to the high cost of insecticide.
2. Parathion-Psylortox treatment returned the highest yield but the parathion component makes it inadvisable to recommend such a treatment for use by unskilled operators.
3. A comparison of DDT/EHC dust, emulsion and wettable powder showed no significant difference in yield but on an economic basis dust and wettable powder are far superior to emulsion, and dust is easier to apply.
4. A comparison of the time-of-application treatments, numbers 5-9 showed that the earlier the treatment is started the better, and that time of application is more important than the number of applications.

(xxviii) HELICOPTERS AS SPRAYING AIRCRAFT. (Miscellaneous Report No. 101)

The following notes have been compiled by Colonial Insecticide Research Unit, Porton.

Both the Bell Type 47G and the Hiller Type 360 are well tried aircraft in the 'light' category, being powered by a 200 H.P. Franklin engine, have the insecticide storage tanks mounted externally, and have a reduced flying endurance when operating with maximum insecticide load, making it highly desirable to arrange for the operations base to be as close to the spraying area as possible. Due to the ability of the helicopter to operate from restricted areas, there is seldom any difficulty in finding a suitable operations base, but it should be remembered that the nearer the operations base to the spraying area the more important it is to have a highly trained staff equipped with efficient ground equipment than would otherwise be the case if the proportion of idle time to flying time is to be kept down.

# HELICOPTERS AS SPRAYING AIRCRAFT (Contd.)

| Manufacturer                                           | Type | Insecticide Load at Sea Level | Cruising Speed | Hovering Ceiling | Service Ceiling | Rate of Climb              | Gross Weight | Total Cost (Inc. Spray App) | Remarks                                                                                          |
|--------------------------------------------------------|------|-------------------------------|----------------|------------------|-----------------|----------------------------|--------------|-----------------------------|--------------------------------------------------------------------------------------------------|
| Bell Aircraft Corporation, Buffalo, N.Y., U.S.A.       | 47G  | 500-lbs.                      | 77 m.p.h.      | 3,600 ft.        | 10,900 ft.      | 800 ft/min. (at Sea Level) | 2,350 lbs.   | \$ 38,000 (approx.)         |                                                                                                  |
| Hiller Helicopters Inc., Palo Alto, California, U.S.A. | 360  | 500-lbs.                      | 70 m.p.h.      | 3,200 ft.        | 9,400 ft.       | 770 ft/min. (at Sea Level) | 1,656 lbs.   | \$ 37,000 (approx.)         |                                                                                                  |
| Westland Aircraft Ltd. Yeovil, Somerset, Gt. Britain   | S-55 | 11850-lbs.                    | 86 m.p.h.      | 5,100 ft.        | 11,000 ft.      | 680 ft/min. (continuous)   | 7,500 lbs.   | \$53,000                    | This model is available for Sterling, a similar one is offered by Sikorsky in U.S.A. for dollars |

The Westland S-55 is a modern machine powered by a 600 H.P. Wright R-1340 engine, a later mark will be powered by a Leonides Major of 800 H.P. The insecticide tanks are carried inside the cabin and as the dual-control cockpit is located above and forward of the cabin, there is no danger of fumes from the insecticide affecting the crew. The insecticide load of 1850-lbs. is calculated on an allowance of 20 minutes flying time plus 17 minutes spraying time plus 20 minutes reserve. An indication of the efficiency of the S-55 design over the S-51 can be gauged from the fact that for an increase of only 4 feet in rotor diameter it has three times the load-carrying capacity.

Details of the Westland S-51 and Bristol 171 Mk. 4 are not given in these notes, for the following reasons:-

- (a) The Westland S-51 (1-Leonides 550 H.P.) has been used for spray work in the United Kingdom but is now obsolescent and is uneconomical to operate, even by helicopter standards.
- (b) The Bristol Type 171 Mk. 4 (1-Leonides 550 H.P.) is of a comparable size to the S-51 and has been approved for a spray installation, but no facts are available at the time of writing.

(xxix) A MOBILE LABORATORY FOR FIELD RESEARCH IN ENTOMOLOGY AND INSECT PATHOLOGY

This bulletin (Research Notes Series, Entomology, E-10, May 1955) issued by the Department of Agriculture, Science Service, Entomology Division, Ontario, Canada, gives a full, illustrated description of a mobile laboratory constructed on a standard chassis of a  $1\frac{1}{2}$ -ton truck with a 161-inch wheel base and four-speed forward transmission. The unit provides laboratory and living accommodation for two persons and was originally constructed to facilitate field studies of a fungous disease, Entomophthora grylli (Fres.) Now., of grasshoppers in Western Canada.

(xxx) SIXTH ANNUAL REPORT OF THE COMMONWEALTH OF AUSTRALIA SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION, YEAR ENDING JUNE 1954  
(Received September 1955)

The following is a selection of extracts relating to pests and their control:-

Sheep Body Louse

"Damalinia ovis has been studied chiefly, with particular reference to the effect of temperature on its ecology. It was shown that the

distribution of eggs of D. ovis in the fleece was determined by the temperature prevailing within the fleece. Lice placed on glass wool and exposed to a temperature gradient laid their eggs between 39° and 36°C., which coincides with the range existing in the fleece. Lice migrate to the warmer region suddenly about 45 min. before oviposition. At first the louse places its head in the warmer region but reverses its position 5 min. before oviposition and places the posterior tip of the abdomen in the warmer region. Oviposition occupies 30 sec., after which the louse returns to the cooler area. Linognathus stenopsis behaved similarly in a goat. When the temperature was equalized throughout a fleece, D. ovis oviposited along the whole length of the wool fibre."

"Further observations confirmed that the preferred site of Linognathus ovillus is the face. It spreads from this area over the ventral aspect of the neck and is brushed on the body. Complete control of this parasite was obtained in a trial with benzene hexachloride at the concentration employed for the control of D. ovis!"

"Studies on the life cycle of Psorergates ovis were continued and, although the previously reported findings were confirmed, it has not yet been possible to determine the exact length of the life cycle."

#### Sheep Blowfly

"Body Strike. The protection given by spraying or jetting DDT, BHC, aldrin, dieldrin and malathion was determined by applying the insecticide to the dorsal areas and then exposing the treated animals to a heavy population of gravid Lucilia cuprina in an insectary with indole plugs inserted into the fleece as an attractant. The anti-larval protection was tested by placing newly hatched maggots of this blowfly on the skin of the treated areas at various intervals after treatment."

"It was quickly determined that jetting gave significantly greater protection against both adults and larvae than spraying. As an anti-adult insecticide DDT (1.0 per cent) proved more lasting than BHC, aldrin or dieldrin (0.25 per cent active ingredient). Further tests of the anti-adult properties of BHC, aldrin, dieldrin, and malathion, at 0.25 and 0.1 per cent active ingredients, showed that BHC at the higher concentration gave considerable protection at five weeks, whereas with the other insecticides protection at this period was poor. Against larvae in one trial aldrin (0.25 per cent) gave good protection for 23 weeks, dieldrin (0.25 per cent) for seventeen weeks, BHC (0.25 per cent gamma isomer) for eighteen weeks, and DDT (1 per cent) for only eight weeks. Another trial which included malathion (0.05-0.25 per cent) showed this insecticide to be much less effective than BHC, aldrin, and dieldrin at similar concentrations. In this trial BHC was less effective than aldrin and dieldrin, which were about equal, giving 17-18 weeks' protection at a concentration of 0.25 per cent. Field trials were carried out with aldrin, dieldrin, and BHC, but unfortunately flies remained inactive".

"Head Strike in Rams. A field trial was carried out with 1 per cent dieldrin jetted into the area at the base of the horns. During the eleven weeks after treatment, twelve strikes had occurred in 111 control rams, whereas none of the 568 treated rams had been struck."

"Treatment of Strike. Preliminary observations have been made on the treatment of artificial strikes by jetting the struck area and surrounding wool with aldrin, dieldrin (0.05-0.2 per cent), and BHC (0.05-0.2 per cent gamma isomer). In all instances the struck areas were free of maggots within 24 hours of treatment, healed quickly, and at the highest concentrations remained resistant to implants of larvae for up to thirteen weeks."

"Systemic Administration of Insecticides. In preliminary work aldrin in peanut oil was administered subcutaneously to guinea-pigs and sheep. At intervals after administration, the blood was tested by a bioassay method against newly hatched maggots of L. cuprina."

"Blood from guinea-pigs 2 hr. after dose rates of up to 20 mg./kg. of body weight was non-toxic to maggots, but when the dose rate was raised to 35 mg./kg. body weight none of the maggots survived."

"Two sheep remained unaffected at dose rates of 50 and 100 mg./kg. body weight and their blood at intervals of 2, 4, 6 and 24 hr. after treatment was not toxic to maggots. These investigations are proceeding."

#### Cattle Tick (*Boophilus microplus*)

"Chemical and Biological Studies. (i) Absorption and Metabolism of Chlorinated Hydrocarbons by Ticks. This investigation was started to provide a chemical method of assessing the resistance of strains of ticks to acaricides. The aspect most intensively examined in the last year has been penetration. It has been found that when DDT is dissolved in an homologous series of normal primary alcohols and applied to cattle ticks, the greatest penetration takes place with butyl, amyl, and hexyl alcohols. A considerable amount of DDT applied in amyl and hexyl alcohols cannot be accounted for in the analysis of DDT from inside and outside the ticks, and is considered to have been metabolized to products which are not detectable with the Schechter-Haller analytical procedure".

"The penetration of gamma-BHC into BHC-susceptible and reputedly BHC-resistant ticks was compared, but no differences were found between the strains in the rates of penetration of the amounts of gamma-isomer retained within the ticks."

"(ii) Depletion of Acaricides from Cattle-dipping Vats. Studies have been made of the gamma-isomer content of BHC cattle dips. The actual gamma content is usually considerably below the value calculated from dehydrohalogenation analysis, or from the known rate of charging and

replenishment. There is evidence that the greatest depletion of laboratory-stored dip samples occurs in the summer months. Chemical breakdown of gamma-BHC has also been demonstrated in some artificially produced hard waters".

"Depletion of DDT in laboratory-stored preparations contaminated with dip detritus is indicated by an increase in the inorganic chloride content, and the presence of DDT breakdown products. However, the extent of DDT depletion so far recorded appears to be of little practical importance".

"(iii) Persistence of Acaricides on Cattle. Measurement of the amounts of DDT on samples of cattle hair collected at intervals after dipping or spraying, correlated with a study of reinfestation with larval ticks, suggests that the presence of more than 1,000  $\mu$ g of DDT per g. of hair protects animals against reinfestation".

"DDT and lindane were formulated with equal proportions of the chlorinated polyphenol "Arochlor 5460" as cattle sprays which, by analogy with the performance of this and allied synthetic resins in other fields of insecticide application, should have resulted in much greater persistency of the toxicants. However, no marked increase in the persistency of DDT or EHC on cattle resulted".

"Coumarone-indene resins formulated with DDT produced a small increase in the persistency of the toxicant as measured by both chemical analysis of hair samples and the rate of reinfestation of the cattle with seed ticks."

"(iv) Malathion. This acaricide, which is an organic phosphate of relatively low toxicity to vertebrates, appeared to have some promise for tick control when tested in the laboratory, but in field trials its performance was rather erratic."

"(v) Dieldrin and Aldrin. Laboratory and field trials have shown that these preparations particularly dieldrin, give a very efficient kill of ticks and prevent reinfestation for at least as long as DDT."

"(vi) Systemic Insecticides. Aldrin, dieldrin, and lindane, as solutions in peanut oil, were injected subcutaneously into animals at the rate of 25 mg./kg. body weight. The animals showed no symptoms of toxicosis. The younger stages of ticks on the dieldrin and lindane animals were killed. Hair samples taken from lindane animal two days after injection were found to contain 117  $\mu$ g. of lindane per g. of hair, while samples taken five days after the injection contained 21  $\mu$ g per g. of hair."

Red-legged Earth Mite (*Halotydeus destructor*) and Lucerne Flea (*Sminthurus viridis*)

"In small scale experiments at the Institute of Agriculture, Nedlands, Western Australia, eleven new insecticides and acaricides were tested against the now standard DDT. None was as effective as DDT, but DCPM and Dilan showed some promise and will be retested in the next season."

"A large scale experiment using the boom spray was carried out at Coomberdale, Western Australia, the treatments being parathion at  $\frac{1}{2}$  oz./acre, parathion at  $\frac{1}{2}$  oz. + DDT at 4 oz./acre, and dieldrin at 4 oz./acre. Parathion + DDT gave excellent control of both lucerne flea and earth mite, though the population of the former returned to normal after three months. Neither parathion (alone) nor dieldrin affected the earth mite, but again parathion gave a complete initial kill of the lucerne flea, the population returning to normal after three months. Dieldrin achieved some control of the lucerne flea with some apparent residual effect, and further tests with it are planned."

Argentine Ants (*Iridomyrmex humilis*)

"In Western Australia, with the co-operation of the Western Australian Department of Agriculture, it was found that a 2 per cent dieldrin spray applied two and a half years before was still killing ants invading the treated areas. A 1 per cent spray was still killing ants one year after application and an 0.5 per cent spray had eradicated them from treated blocks except where soil had been disturbed. Aldrin and DDT gave results inferior to dieldrin."

55/31 FIRST ANNUAL REPORT OF THE MALARIA CONTROL PILOT PROJECT IN WESTERN SOKOTO (NORTHERN NIGERIA) 1954-55.

L.J. BRUCE-CHEWITT. Malaria Service, Federal Department of Medical Services, Nigeria.

This report deals with the last phase of preparatory surveys, the commencement of control operations, the technique of the two full subsequent spraying cycles and with the entomological, malariometrical and chemical investigations carried out during the period February 1954 - April 1955. The objective of the project is the control of malaria in a rural area by the application of residual insecticides in human and animal dwellings. No larvicidal campaign is contemplated. The project is a joint responsibility of the Government of the Federation of Nigeria and of W.H.O. and U.N.I.C.E.F.

Precontrol surveys were carried out in 1952 and 1953 and organization of the project by the Federal Malaria Service detachment at Birnin Kebbi began in January 1954.

#### Description of the Area

The area is situated mainly in the Birnin Kebbi District of the Gwandu Emirate, Sokoto Province, Northern Nigeria and forms a rough quadrangle 34 miles long by 18 miles wide. The climate in this region is Sudanic in character with a well marked wet season from April to October. The monthly mean temperature ranges from 50°F in December to 110° in April and May. Diurnal variations in temperature reach their maximum of about 50°F in March. The prevailing wind in the rainy season is S.W. and from November to February the extremely dry Harmattan blows from the N.E.

The greater part of this area of Sokoto Province consists of gently undulating sandy plains with an average elevation of 1000 feet above sea-level. The vegetation is of the savannah type characterised by continuous grass cover and widely dispersed trees.

The inhabitants are mainly farmers living in compounds which are collections of round, mud-walled huts. The nomad, cattle-droving Fulani people live in encampments of light transportable huts. The total population of the area is over 120,000.

#### Malariometry

Judged by the results of malariometric investigations over the last few years, there can be no doubt that the area is holoendemic. That a holoendemicity of such a high order should be present in an area with a

transmission season apparently much shorter than in Southern Nigeria is of considerable interest. There is evidence of a pronounced endemic wave following the peak of the rainy season. The level of collective immunity is perhaps lower than in Southern Nigeria but still high enough to prevent any seasonal striking epidemics. A decline in spleen and parasite rates seen in infants and children during the first quarter of 1955 may be the first sign of the expected decrease in the amount of malaria in the area.

## Entomology

The following investigations have been carried out during the period 1953-55:-

- (1) Collection and identification of adult mosquitoes from Capture Stations and calculation of the Average Anopheles Density, females per room per day.
- (2) Dissection of collected anopheles for sporozoites in salivary glands. (Also for nematode larvae in proboscis).
- (3) Collection of anopheles in special sites (horse stables, trap pots, rat-burrows, wells, zana-mat fences, culverts and also sprayed huts).
- (4) Collection of anopheles in a modified Magoon trap using various baits. Night collections in the open on human bait.
- (5) Collection and identification of larvae of Anopheles and Culicines in natural breeding foci. (Also for Aedes Index).
- (6) Collection of selected batches of mosquitoes for precipitin tests and for maxillary indices.
- (7) Investigation of the gonotrophic cycle and of the longevity of two main vectors by grading of ovarian development and by taking the measurements of the ampulla.

1. Average Anopheles Density. The chief anopheline species are A. gambiae, funestus, rufipes and pharoensis. The project area is divided into three zones, the first sprayed with DDT, the second with Dieldrin and the third with BHC. Spraying commenced in these three zones in April, June and July 1954 respectively.

TABLE I

Monthly distribution of the two main vectors in unsprayed areas and the three sprayed zones 1953-1955 expressed as AAD (females per room/day)

| Year | Period      | All unsprayed areas | DDT zone | Dieldrin zone | BHC zone |
|------|-------------|---------------------|----------|---------------|----------|
| 1953 | March-April | 19.8                | —        | —             | —        |
|      | August      | 44.0                | —        | —             | —        |
|      | September   | 240.0               | —        | —             | —        |
|      | October     | 150.0               | —        | —             | —        |
| 1954 | February    | 28.3                | —        | —             | —        |
|      | March       | 34.9                | —        | —             | —        |
|      | April       | 26.8                | —        | —             | —        |
|      | May         | 20.2                | 3.0      | —             | —        |
|      | June        | 55.4                | 5.4      | —             | —        |
|      | July        | 94.1                | 12.4     | 13.0          | —        |
|      | August      | 99.5                | 22.8     | 37.5          | 22.2     |
|      | September   | 140.7               | 38.1     | 28.0          | 5.6      |
|      | October     | 164.5               | 7.8      | 6.4           | 3.4      |
|      | November    | 45.4                | 4.0      | 9.0           | 4.0      |
|      | December    | 29.8                | 1.0      | 5.0           | 1.4      |
| 1955 | January     | 8.1                 | 0.3      | 3.4           | 0.7      |
|      | February    | 16.8                | 0.4      | 2.0           | 0.5      |
|      | March       | 12.7                | 0.24     | 1.55          | 0.3      |

2. Infectivity of Anopheles. The infectivity of anopheles from Capture Stations was investigated by dissections (within 24 hrs.) of females for sporozoites in salivary glands. The 1954 results are somewhat at variance with previous experience. The rarity of infected A. funestus and the relatively low sporozoite rate found in A. gambiae, even outside the control area, are surprising and cannot be adequately explained at the present time. A thorough investigation of these problems is planned for 1955.

TABLE 2

Infectivity of two main vectors during pre-control surveys

| Dry season 1953 |           |          |      | Rainy season 1953 |          |      |
|-----------------|-----------|----------|------|-------------------|----------|------|
|                 | Dissected | Infected | %    | Dissected         | Infected | %    |
| A. gambiae      | 774       | 1        | 0.13 | 897               | 31       | 3.46 |
| A. funestus     | 1,425     | 1        | 0.07 | 682               | 16       | 2.35 |

TABLE 3

Mean sporozoite for A. gambiae & A. funestus for the period  
July 1954 - February 1955

| Treated Villages |          |      | Untreated Villages |          |      |
|------------------|----------|------|--------------------|----------|------|
| Dissected        | Infected | %    | Dissected          | Infected | %    |
| 1,158            | 1        | 0.09 | 703                | 8        | 1.14 |

Records of nematodes (? F. bancrofti) found in the probosces of A. gambiae and A. funestus were also kept. During the period April 1954 to February 1955, the infection rates were 2.5% in 2,036 gambiae and 1.3% in 871 funestus.

### 3. Collection of Anopheles from horse-stables.

TABLE 4

Results of spray collection of mosquitoes from horse-stables in  
Birnin Kebbi from April 1954 to February 1955  
(Expressed as number of females per horse/day)

|                            |                             |
|----------------------------|-----------------------------|
| <u>A. gambiae</u><br>2.9   | <u>A. funestus</u><br>0.6   |
| <u>A. rufipes</u><br>0.3   | <u>A. pharoensis</u><br>1.4 |
| <u>A. coustani</u><br>0.6  | <u>A. squamosus</u><br>0.3  |
| <u>A. moucheti</u><br>0.03 | <u>Culex sp.</u><br>7.0     |

### 4. Collection of Mosquitoes from Traps.

TABLE 5

Records of Anopheles collected in the Magoon trap with various animal  
baits. Expressed as female Anopheles per host/night/exposure.  
(February - July 1954)

| Bait   | <u>A. gambiae</u> | <u>A. funestus</u> | <u>A. rufipes</u> | Other<br>Anopheles | Culicines |
|--------|-------------------|--------------------|-------------------|--------------------|-----------|
| Donkey | 2.8               | 1.4                | 2.3               | 0.1                | 196.7     |
| Calf   | 1.1               | 1.7                | 6.7               | 1.5                | 320.5     |
| Goat   | 0.5               | 1.0                | 0.5               | 1.6                | 143.5     |
| Sheep  | 0.3               | 0                  | 0.3               | 1.5                | 134.0     |
| Horse  | 1.0               | 0.5                | 1.0               | 0.3                | 62.0      |

Note: Other anopheles consisted of A. pharoensis, squamosus, coustani and moucheti.

#### 4.1 Outdoor Biting of Anopheles.

TABLE 6

Collections in the open on human bait between 20.00 hrs. and 23.00 hrs.  
(mean nos. of females per man/hour of exposure)

|                    |                      |                     |                      |                 |                  |
|--------------------|----------------------|---------------------|----------------------|-----------------|------------------|
| A.gambiae<br>0.036 | A.pharoensis<br>0.05 | A.coustani<br>0.006 | A.wellcomei<br>0.006 | A.nili<br>0.006 | Culicines<br>5.1 |
|--------------------|----------------------|---------------------|----------------------|-----------------|------------------|

Note: Among the Culicines collected 45% were Taeniorhynchus spp.

4.2. Outdoor Resting of Anopheles. Two main types of resting place have been recognised.

Type I. Recesses in cornstalk mat fences and culverts (often only a few planks across a dry ditch).

Type II. Pots, rat burrows, wells and treeholes.

Females collected from type I are often blood fed or gravid whereas those from type II are often newly emerged.

5. Larval Surveys. Owing to a shortage of trained staff few collections of larvae could be made during the year under review. Surveys of larval breeding and of Aedes indices in the towns showed evidence of a decline. The Aedes Index in Birnin Kebbi decreased from 18.7 in 1953 to nil.

6. Maxillary Index. Investigation of the maxillary index in A. gambiae gave no support to the theory of a separate zoophilic race of high maxillary index.

6.1. Precipitin Tests. 60% of A. gambiae found out of doors had fed on man the previous night while in the case of A. funestus 21% had done so. Both species show a considerable deviation to horse. All other anopheles show a preference for mammalian blood, particularly the horse. The investigation shows that, given a free choice A. gambiae feeds on cattle almost as often as on man.

7. The age structure of the A. gambiae and A. funestus population from capture stations inside and outside the sprayed zones has been investigated. In both the dry and wet seasons some indication of decreased life-span in the sprayed areas was found. During the dry season this was probably sufficient to interrupt malaria transmission, but in the rains the effect was less marked.

7.1. Investigation of the stages in the gonotrophic cycle reached by female anopheles from capture stations show that in the sprayed zones in both vector species the proportions of later stages of the cycle are somewhat reduced, due either to higher mortality or to increased exophily.

7.2. Analysis of catches by ovary stage shows that the stage 1 of Christophers, indicating extreme youth, is commoner in the population of the diendrin zone than in the unsprayed areas, confirming the conclusion that the average life span of the anopheles has been reduced.

#### Control Operations

The Project area includes

- 1 town of about 12,000 inhabitants
- 2 towns of about 10,000 inhabitants
- 5 towns between 5,000 and 7,000 people
- 9 village groups of 3,000-4,000 people
- 14 village groups of about 2,000
- 7 village groups with about 1,000
- 9 village groups with about 500

and a small and fluctuating number of villages or grouped hamlets with 100-200 each. The division of the area into three zones each treated with a different insecticide was planned according to the ratio 3:2:1 for Dieldrin, DDT and BHC respectively.

| <u>Zone</u> | <u>Population</u> | <u>No. of huts</u> |
|-------------|-------------------|--------------------|
| Dieldrin    | 60,218            | 39,345             |
| DDT         | 43,187            | 24,471             |
| BHC         | 21,186            | 16,425             |

The theoretical dosages of the three insecticides are shown in the following table

TABLE 7

|                                                             | DDT                                                                              | Dieldrin           | BHC                                              |
|-------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------|--------------------------------------------------|
| Dosage of toxicant<br>p. sq. foot                           | 200 mgm of para-<br>para                                                         | 25 mgm             | 25 mgm of gamma<br>isomer                        |
| Formulation<br>available                                    | 75% water-dispersi-<br>ble DDT technical<br>powder with 75%<br>para-para content | 50% w.d.<br>powder | 50% BHC w.d.<br>powder with 6.5%<br>gamma isomer |
| Ideal dosage of<br>formulation<br>p. sq. foot of<br>surface | 356 mgm                                                                          | 50 mgm             | 388 mgm                                          |

Throughout the first spraying cycle the actual dosage of DDT formulation was 30% below the ideal dosage; this error is being corrected in subsequent cycles.

### Spraying Equipment

The Hudson "X-pert" No. 710 compression sprayer (capacity 2.5 Imperial gallons) is the standard equipment for the spraying teams. The nozzle is a flat-fan Tee-jet made of brass or steel (No. 8002 or 8004, the latter with twice the output of the 8002).

Although sturdily made and quite efficient when in good condition these sprayers suffered considerably at the hands of unskilled labour at the commencement of spraying. However as the operators became more skilled the incidence of damage decreased considerably. A report on the sprayer has been submitted to W.H.O.

### 55/32 AN EXPERIMENTAL MALARIA CONTROL SCHEME IN ILARO A SEMIRURAL HOLOENDEMIC AREA OF SOUTHERN NIGERIA, REPORT ON FIVE YEARS RESULTS 1949-1953

L.J. BRUCE-CHWATT, H.M. ARCHIBALD, R. ELLIOTT, R.A. FITZ-JOHN and I.A. BALOGUN. Malaria Service, Department of Medical Services, Federation of Nigeria, Information Bulletin No. 3. (Received Sept. 1955).

The object of the Ilaro Scheme carried out from 1949 to 1953 was to assess the possibility of malaria control in a relatively small (12 sq. miles) semi-rural area situated within the holoendemic zone of malaria endemicity in Southern Nigeria. The method of control was by the use of a residual insecticide exclusively as an imagocide without any larvicidal methods. The insecticide used was "Gammexane" P520 (I.C.I.), a 50% benzene-hexachloride water-dispersible powder with a 6.5% content of the active gamma isomer. It was used in eleven continuous 3 month cycles from 1950 to 1952 at an initial dose of 10 mgn gamma isomer per sq. foot. In August 1951 this dose was increased to 15 mgn gamma isomer per sq. foot.

In January 1953 the spraying routine at Ilaro was stopped but the collection of malariometrical and entomological data continued until the end of that year.

(2) The results of the scheme were assessed throughout five years by continuous collection of adult mosquitoes from twenty unsprayed Capture Stations distributed over the control area and by an equally

continuous collection of larvae from known breeding places. The Average Anopheles Density was calculated separately for each anopheline species in terms of female anopheles per Capture Station room per day. The Larval Density Index was based on the number of larvae of each anopheline species found in 100 dips of a ladle.

All the usual malarimetric indices were determined regularly in large samples of the Iraro population; the demographic trends of this population were also estimated on the basis of records obtained by a simple registry of vital statistics set up for this purpose.

(3) Entomological results of the scheme have shown that the reduction in numbers of A. funestus was fast and that this anopheles was practically eliminated at the end of the first year of the residual spraying. The density of A. gambiae, the main vector of malaria, decreased by 90% during the first and second year, but this species maintained its presence in small numbers and even increased slightly during the third year of spraying. There was evidence that most of A. gambiae found in 1951 and 1952 were coming from the vast area outside the controlled zone.

The cessation of spraying in 1953 was followed during the rainy season by a rise in the adult A. gambiae density to about  $2\frac{1}{2}$  times its mean 1952 value (0.43 to 1.18). A. funestus did not re-appear until December 1953 and even then was represented by one specimen only.

The investigation of the out-of-door biting activity of anopheles has revealed that a certain number of A. gambiae could obtain a blood-meal on man outside of houses and thus, should its day-time shelters be other than human dwellings, might not come into contact with insecticide. The amount of this out-of-door feeding is greatest near the peak of the breeding season of A. gambiae.

The infectivity rate of anopheles was assessed by the sporozoite rate. It was found that the annual sporozoite rate of A. gambiae fell from the mean 5% in 1949, to an average of 0.6% in 1951, 1952 and 1953. No infected A. funestus were found after the first 3 months of residual spraying and this nil rate continued until the end of 1953.

Regular collections of anopheline larvae were made throughout the period in the breeding places revealed by the original entomological survey and in others located from time to time. A. funestus has shown the most marked reduction: with the exception of six larvae found in one breeding place in August 1951 none were found after May 1950. A. gambiae on the other hand, while drastically reduced in number (by 90% between 1949 and 1952) continued to appear in the collections from many breeding places, particularly at the periphery of the controlled area.

The breeding density of A. gambiae increased slowly after the cessation of spraying in 1953 and that for A. funestus remained at nil until November 1953 when a few A. funestus larvae were found for the first time since 1950.

(4) The main malariometrical indices of the Ilaro population were determined in seven age-groups regularly throughout the five years duration of the scheme. In infants and in very young children they showed a considerable decrease over the period of control but this decrease was less obvious in older children, still less in adolescents, while in adults no change was noticeable.

In infants, the Spleen Rate fell from 16% to 6.5% during the three years of spraying. In toddlers, the corresponding reduction was from 66% to 45%. In older children the decrease was less obvious and it was insignificant in adolescents and adults.

The same trend occurred in the Crude Parasite Rate and was more marked. This rate in infants fell from 33% to 10%, in toddlers from 81% to 40%, and in young school-children from 75% to 52%. In older children and adolescents a less pronounced fall was observed, but no change in the adult rate was detected.

(5) The malaria morbidity in the local population, estimated from the local dispensary records, showed a gradual decrease from the average figure of 6% in 1949 to less than 1% in 1952. At the same time the total number of attendances fell off. After control stopped, the malaria morbidity rate for 1953 rose slightly for the first time since 1950.

The Crude Birth Rate estimated from the records of the local registry showed a slight upward trend over the period 1950-1952 as compared with 1949. The Crude Death Rate, on the other hand, decreased during the same period. It is not thought, however, that these slight changes are of great significance.

The Infant Mortality Rate decreased strikingly from 137 per thousand in 1949 to about 70 per thousand in 1951, 1952 and 1953. During the latter year there was a slight rise in the Infant Mortality Rate.

(6) Assays of insecticide deposits on sprayed walls showed that on the average the BHC dosage aimed at was achieved and, indeed, during the last two years of spraying slightly exceeded the dose of 15 mgm BHC gamma isomer per square foot (0.15 mg per sq. metre).

Chemical estimation of residual deposits followed by bio-assays suggested that the initially high insecticidal activity of the BHC deposit on walls of houses in Ilaro decreased fairly rapidly.

Approximately 80% of its activity was lost at the end of the ordinary quarterly spraying cycle.

(7) The estimated costs of the Ilaro Scheme averaged £3,250 per annum or approximately 5 shillings and 2 pence per capita of protected population per year.

(8) Conclusions drawn from the Ilaro Scheme, which from its start was conceived as a small-scale field experiment in residual spraying, are:

- (a) That the residual spraying of 2,500 houses in that area produced rapid elimination of A. funestus and considerable reduction of A. gambiae. Elimination of the latter was never achieved. In small numbers it continued to invade the controlled zone from the vast surrounding area, even although there were no unsprayed human habitations within a three miles radius. This shows clearly that the success of malaria control by residual insecticides would depend in Tropical Africa as elsewhere, on controlling a much larger area than that of 12 sq. miles, the area controlled at Ilaro.
- (b) That the continuous control of one of the two main vectors, with the considerable reduction of the other, changed in three years the picture of local malaria in the small holocendemic Ilaro area to a considerable degree. It seems that it is possible to decrease but not eliminate malaria transmission in such a relatively small area surrounded by a large uncontrolled territory. Two factors adversely affect the result: the influx of infected anopheles from outside the control limits and the mobility, commonly underestimated, of the African population.
- (c) That the initially advocated dose of 10 or even 15 mgm gamma isomer BHC per sq. ft. is certainly too low and that the satisfactory residual effect of this dose on the mud walls of Ilaro houses is much shorter than the expected 3 months. This agrees with the findings of many other workers in Tropical Africa (Macdonald and Davidson, 1953) so that there is now a growing tendency to use BHC in much higher doses in an attempt to prolong the duration of residual action, or to choose other insecticides with longer persistence.

The fact remains that the picture of malaria at Ilaro underwent marked changes between 1950 and 1952, during the maintenance of the experimental residual control scheme. Such results, achieved in a small area supersaturated with malaria, with a long period of transmission

and surrounded by a dense tropical forest leave little room for doubt that better results can be expected from larger and more sustained projects carried out in West Africa generally and in Nigeria in particular.

Such a project was started in 1953 in Northern Nigeria and is now in its second year. The Malaria Control Pilot Project in Western Sokoto sponsored by the World Health Organization, by the United Nations Children's Fund, and carried out jointly by the Northern Regional Government and by the Malaria Service covers an area of 600 square miles and will project a population of 124,000. The results of that Pilot Project will answer some questions posed by the Ilaro Scheme and will provide a firm basis from which country-wide malaria control in West Africa could be contemplated.

55/33 ANNUAL REPORT OF THE MOSQUITO CONTROL SERVICE. BRITISH GUIANA FOR 1954 (Received August 1955)

As recorded in the 1953 Annual Report, the aim of a Colony wide malaria control programme launched in 1947, and based solely on residual DDT house spraying, had been achieved, and for all practical purposes, this achievement was maintained in 1954 by routine DDT "barrier" control techniques.

#### Malaria

Despite ideal mosquito-breeding conditions created by continuous heavy rainfall throughout the year, malaria remained at insignificant levels. Of the 163 clinical slides received for examination at the Mosquito Control Service Laboratory only 23 were found to be positive, whilst of 428 slides examined at the Central Medical Laboratory only 4 were found to be positive. Positive cases originated mainly from remote riverain and hinterlands whilst two, one reported from Georgetown and the other from the Upper Mazaruni Amerindian Reserve, were traced to localities sufficiently off the beaten track to have escaped the routine residual DDT spraying programme.

Dr. L.J. Charles collected specimens of Anopheles (Kertessia) bellator, breeding in six bromeliads and in Brocchinia micrantha. Further observations are required to define the distribution of this potential malaria vector.

Only case of death from malaria was returned to the Registrar General as compared with 8 in 1953.

Routine entomological check surveys on the coastlands yielded approximately 311,300 adult mosquitoes of which about 99% were Culex fatigans. No Anopheles darlingi were discovered. Numerous Anopheles larvae identified as A. aquasalis and A. albitarsis were collected.

## Yellow Fever

No clinical case of yellow fever was reported. Reinfestation of Georgetown by Aedes aegypti continued to reveal itself in unrelated patches in those sections of the city which were negative and left unsprayed in December 1953. Consequently a complete DDT residual treatment of the city was undertaken. No difficulties have been encountered in Aedes control with single applications of DDT although in neighbouring Dutch Guiana Aedes aegypti resistance to DDT is being actively investigated. A marked improvement of ship-borne Ae. aegypti from the Eastern Caribbean was observed during the year, attributable to the P.A.S.B. - U.N.I.C.E.F. sponsored Insect Control Programme.

## Filariasis

Filaria surveys were carried out at the two unsewered suburban areas of Kitty and La Penitence. At Kitty a total of 500 samples of all wages was examined and 15 adults and 21 children were found to be infected with microfilaria. At La Penitence, a similar sample yielded 33 adults and 13 children infected with microfilaria.

The great hope entertained for controlling and probably eradicating the filaria vector Culex fatigans with Dieldrin, as a result of the success of field experiments with this insecticide, has waned, in view of recent expert opinion that Dieldrin stimulates the production of resistant strains to both DDT and BHC. Projected field trials with Dieldrin have been postponed indefinitely.

## Laboratory Studies

A major research project was completed on the investigation of the relative toxicity of 13 insecticides to Culex fatigans. As a result of these studies Dr. L.J. Charles concluded that although gamma BHC 98% and lindane 99% are initially the most toxic insecticides, nevertheless, Dieldrin, by virtue of its greater persistent effect, remained the residual insecticide of choice. However the use of Dieldrin has been discontinued for the reason stated in the previous paragraph. In larvicidal control of C. fatigans, the organo-phosphorus insecticide EPN was greatly superior to any tested.

## Field Operations

Routine DDT "barrier" control was maintained - in the riverain areas on an annual cycle, and on the Coastlands on an 18-month schedule.

## Staff

The malaria investigation and control programme was carried out under the direction of Dr. H.P.S. Gillette, Malariologist, assisted until October by the late Major R.A. Senior White, Entomologist; Dr. F.R.S. Kellett, Medical Officer, Mr. T. Omardeen, Assistant Entomologist and a Field Staff of Sanitary Inspectors, Field Assistants and Laboratory Technicians.

## Malaria Studies

Spleen rates were determined at 49 schools. 6,695 children were examined and only 32 (0.48%) with enlarged spleens were discovered. 2,286 blood slides were taken of which 13 proved positive. (10 P.falciparum and 3 P.vivax).

Results for all slides examined by the Division during the year were as follows:-

|                                                |             |
|------------------------------------------------|-------------|
| Total number of slides examined.....           | 4117        |
| Number of positive slides.....                 | 220 (5.3%)  |
| Number positive for <u>P. falciparum</u> ..... | 123 (55.9%) |
| " " " <u>P. vivax</u> .....                    | 95 (43.2%)  |
| " " " <u>P. malariae</u> .....                 | 2 (0.9%)    |

## Entomological Section

1. Five base line traps were operated almost continually throughout the year and details of the catches for A. aquasalis, albitarsis, and neomaculipalpus are tabulated. There was a marked reduction in aquasalis density (about 50%) as compared with 1953.
2. Miss J. Wall of the London School of Hygiene and Tropical Medicine was on loan to the Division for a period of three months for the purpose of studying the possibility of establishing a cage colony of Anopheles aquasalis at the Insectory which had been built along the lines of the pattern established by Russell and Rao in South India.
3. Studies were commenced with Anopheles albitarsis and A. neomaculipalpus to determine what part, if any, these species play in malaria transmission in Trinidad.
4. Other investigations have been concerned with outside resting, micro-climatic conditions, maxillary index of A. aquasalis, breeding in

permanent and temporary pools around the Insectary Compound, mangrove breeding, and precipitin tests.

5. Routine anopheline adult and larval surveys were continued and details of the catches are tabulated.

## Malaria Control

For the fourth year in succession the malariologist stresses the urgent need for a Sanitary Engineering Unit within the framework of the Health Department to undertake capital works in malaria control engineering. Temporary control measures by ditching, oiling, grading and draining were effectively executed in 1954, but it is pointed out that nearly all the areas controlled in this way lend themselves ideally to a comprehensive programme of capital works. Until such works are put in hand the recurrent annual expenditure must be continued.

The spraying of the major host plants (Bromeliads) of Anopheles bellator with copper sulphate and their manual removal, where necessary, was satisfactorily carried out in two districts of the Colony.

## Residual DDT House Spraying Programme

The programme was considerably expanded during 1954 and practically all houses in the Colony were sprayed during the year. The Lofstrand, Myers Knapsack and Saval Spraycans are the types most generally used for spraying. The Lofstrand and Myers Knapsack gave satisfactory service. The Saval spraycans were found to be heavy whereas the Hudson Sprayers gave some trouble, particularly in respect to the short life of the rubber gaskets.

## Laboratory Testing of DDT Formulations Against Aedes Aegypti

In the latter part of 1953 it was reported that immunity to Yellow Fever had been encountered in two young women in the Plum Mitan district of the island. Prior to this finding it had been assumed that Yellow Fever was completely absent from the island, the last known case having been reported more than forty years ago.

For some years there had been an increasing prevalence of Aedes aegypti and in 1950 after an island-wide survey, a comprehensive scheme for the elimination of the mosquito was drawn up. Due to lack of funds however the programme was not implemented at that time, but after the positive findings at Plum Mitan in 1953 a campaign was launched in that district. During the course of this work it was observed that 100% kill of Aedes aegypti was not obtained with the recommended dosage of DDT

either in suspension or emulsion. Between June and the end of August 1954 several cases of Yellow Fever were reported and coincident with the first case an intensive programme of control against the mosquito was launched. The Division had for many years conducted a DDT Residual House Spraying Programme as a malaria control measure and this was now supplemented by residual spraying of water containers and larviciding measures by means of DDT suspension or emulsion. It was again observed that DDT applied to water containers at the recommended dosage of 1 p.p.m. failed to give total mortality in 24 hours. This result was confirmed by officers of the Pan American Sanitary Bureau who carried out tests in Trinidad in June 1954, but they declined to accept that the problem in Trinidad was in any way different to that of dozens of other similar places in South America where Aedes aegypti has been eradicated by a single application of DDT residually and perifocally.

Following these observations it was decided that laboratory tests should be made to determine (a) the optimum dosage for total kill in 24 hours, and (b) the possibility of resistance having developed. Meantime the field dosage was arbitrarily fixed at not less than 20 p.p.m.

A colony of A. aegypti was started with larvae collected from water containers. Twenty eight tests have been completed in five series A to E; the results are summarised as follows:-

#### DDT Suspensions

In series A, 1000 larvae in 40 separate containers were treated in the 10 tests with 1 p.p.m. DDT. The average mortality obtained was 0.1% after 6 hours, 2.8% after 24 hours and 12.7% after 48 hours exposure. This indicates that even under controlled laboratory conditions a concentration of 1 part of DDT per million applied as a suspension is inadequate for the control of Aedes aegypti larvae.

The results obtained at concentrations higher than 1 p.p.m. were progressively better, and seemed to justify the increased rates of application adopted in the present programme. However the average mortality obtained with DDT at 20 p.p.m. was only 1% after 6 hours, 46.4% after 24 hours and 69.1% after 48 hours exposure. This result suggested that even at the concentrations used in the field (20 p.p.m.) total mortality could not be achieved in a reasonable time with a single treatment. Further the higher concentrations used were disappointing. 200 p.p.m. were used in Series A and up to 500 p.p.m. in Series E. In none of these tests was 100% mortality obtained after 48 hours.

In addition to the larvae which were dead at the various times of observation there were several larvae which, though they were not dead, were visibly affected by the DDT and were unable to swim up to the

surface but lay wriggling on the bottom of the bowl. There were classified as "Sick". The number of sick larvae was usually higher at 6 hours and 24 hours than at 48 hours. Other larvae however in all the concentrations appeared normal even after 48 hours and some of them pupated towards the end of the test.

### DDT Emulsions

In series B, emulsions were used instead of suspension, 1 p.p.m. gave no significant results, but total mortality was obtained in several of the tests even though the highest concentration contained only 50 p.p.m. This was a very encouraging result coming after the disappointing behaviour of the suspensions and in Series D the comparative tests with Xylene-Antarox-DDT and Xylene-Antarox showed that while the solvent and emulsifier played some part in causing mortality DDT in the form of an emulsion was infinitely more effective at the same concentration than a suspension. The quantity of emulsion required to ensure total mortality within 48 hours of Aedes aegypti larvae is large (50 p.p.m.)

### General

This work is being continued with the purposes of confirming the above results and of obtaining further information on the behaviour of the local Aedes aegypti to DDT and other insecticides.

It must be mentioned that with the side-spread use of DDT in the Colony during the last 10 years both through Government Insect Control Programmes and commercial distribution, it has not been possible to obtain Aedes aegypti from any place where the mosquito may not have had some previous contact with DDT. The area from which the mosquitoes were collected for the Colony now in use has had eight residual treatments with DDT since 1946. It has seemed desirable to modify the present programme in the light of these indications and now that the whole island has had one treatment with DDT by the perifocal method without the desired effect on the Aedes index, the programme will be continued by the intensive treatment of small areas in several short cycles, moving to new areas when the index of the treated area has been reduced to 1% or less.

The results here obtained are regarded as giving trends only and this preliminary work has given experience in handling the several problems inherent in such tests.

E. BORDAS and L. NAVARRO (June 1955). WHO/Mal/125  
15 pages plus 17 pages of diagrams, charts etc.

The reports by Muirhead Thompson concerning the repellency effect of DDT on Anopheles gambiae gave rise to serious concern among malariologists, and much additional work on the chemical, physical and insecticidal properties of DDT for antimalarial purposes ensued.

The present paper covers studies carried out in Mexico with the object of comparing the anti-imago properties of insecticides other than DDT and investigating all possibilities of such insecticides in malaria control, especially in cases where DDT might not give the control expected. Repellency, vapour toxicity and adsorption in mud were also studied.

A detailed description of materials and techniques is given as an appendix to the report. The field experiments were planned around the habit patterns of A. pseudopunctipennis. Adults of both sexes of this species normally enter houses at about 6 a.m. and leave at 7 p.m., engorged females remain in-doors for three days until the ovaries are completely developed.

Six huts were constructed with entrance tunnels and exit traps, and observations were made at weekly intervals throughout the season as follows:-

- Day 1, 9 p.m. - traps and sheets placed in position,
  - Day 2, 8-10 a.m. - mosquitoes repelled into traps counted,
    - 1-p.m. - dead mosquitoes on sheets removed and counted
    - 8 p.m. - traps removed and mosquitoes counted and placed in flasks for 48 hours observation.
- Mortality then recorded.

#### Vapour Repellency and Vapour Toxicity

For the purpose of studying repellency and vapour toxicity insecticides were introduced into some of the huts via specially built frames. These took the form of shallow boxes, approximately 8.3 x 2.3 x 0.17 feet, the top covered with gauze and the bottom by paper the inside surface of which carried the insecticide deposit. Mosquitoes could therefore be exposed to the vapour of the insecticide without coming in contact with the deposit. The frames, three per hut, covered only about 19.1 sq. ft. or approximately one-sixth of the total interior surface of a hut.

The treatments were as follows:-

|              |                                                                                       |
|--------------|---------------------------------------------------------------------------------------|
| Hut 1        | 9.0 g DDT                                                                             |
| Hut 2        | 1.0 g lindane                                                                         |
| Hut 3        | 1.75 g lindane and freshly treated frames (1.5 g lindane) reintroduced 40 days later. |
| Hut 4        | 4.5 g Dieldrin                                                                        |
| Control huts |                                                                                       |

### Summary of Results

DDT. Mosquitoes were not prevented from entering the treated hut. Once inside there was no indication of irritability or repellency as observed when mosquitoes came in contact with sublethal doses of DDT.

Lindane. Following the introduction of the treated frames no mosquitoes were captured from the huts for about 2 weeks. Captures then began to increase in size and at the end of a further three week period were comparable to those from the control hut. Total 48 hours mortality fluctuated from 20 to 60%. Some mosquitoes were found dead on the sheets. Practically no mosquitoes were found in morning window trap. Upon the reintroduction of freshly treated frames the story repeats itself. These results are interpreted as follows: at first the lindane vapours repel the mosquitoes before they enter the hut, later as the vapour density falls off the mosquitoes enter the house and are affected by the vapours.

Dieldrin. Before treatment captures in both houses were similar. After introduction of the treated frames only a slight reduction in captures occurred in the treated hut and all the mosquitoes were found dead on the floor. The activity of the insecticide remained unchanged for 60 days when termination of the mosquito season made further observation valueless. There was no repellency at a distance and only a small degree of irritability.

### Partial Spraying on Mud Surfaces

Once the vapour toxicity of lindane and Dieldrin was well established the authors speculated on the possibility of limiting the surface to be sprayed to only two walls, roughly one-third of the interior surface. After the 1953 season the insecticide frames were withdrawn and three of the huts were sprayed as follows:-

|              |                  |                    |
|--------------|------------------|--------------------|
| Hut 1        | 22.0 g chlordane | over 113.4 sq. ft. |
| Hut 2        | 10.0 g Dieldrin  | over 113.4 sq. ft. |
| Hut 4        | 6.0 g lindane    | over 113.4 sq. ft. |
| Huts 2 and 5 | left as controls |                    |

The quantities of insecticides used were decided upon on the basis of cost, each quantity being equivalent, in cost, to 60 g of DDT, the amount necessary to completely spray the hut at a rate of 200 mg/sq. ft.

The huts were sprayed on October 30th 1953 and counts began on April 20th 1954. Vapour toxicity tests, in which caged mosquitoes were exposed in the huts for 5 and 10 hours at a time, were made from July to October 1954.

#### Summary of Results

Chlordane. The results suggested some repellency at a distance and some irritability.

Lindane. Captures in the treated hut were very small indicating repellency at a distance. There was an interesting increase in mortality rates during the season. 5 and 10 hours exposure to the vapour resulted in 57 and 85% mortality respectively. Lindane sprayed on mud maintained its activity for a comparatively long time.

Dioldrin. Captures from the treated and control huts were closely similar, suggesting an absence of repellency. As with lindane, mortality increased as the season progressed. Vapour toxicity was slightly lower than that of lindane, giving 35% mortality for a 5-hour exposure and 75% mortality for 10 hours.

#### Duration of Residual Toxicity by Laboratory Bioassay

Tests have been carried out for the past five years to determine the duration of the residual toxicity of insecticides when sprayed on a variety of commonly encountered building materials. A. quadrimaculatus and A. albimanus were exposed to the treated surfaces for 15 or 60 minutes and 24 hour mortalities were noted. For the vapour toxicity tests, the mosquitoes were separated from the sprayed surface by a screen at 1 cm. distance.

#### Summary of Results

DDT. A deposit of DDT 2 g/m<sup>2</sup>, on most surfaces, will give 100% mortality for 15-minute exposure over a period of 15 months or longer. On mud surfaces, the duration varies from a few days to three years. The variation is apparently related to the iron oxide contents in mud.

Chlordane. Under laboratory conditions, a deposit of 100 mg/sq.ft. has good contact toxicity of short duration. The longest toxicity was observed to be five months on old wood whereas on mud the contact toxicity was the shortest. Vapour toxicity was fair (100% mortality

for one-hour exposure) for most materials, and good in mud for a short period of time. The duration of the residual toxicity on different kinds of mud is the same.

Lindane. A 25 mg/sq.ft. deposit showed good residual contact toxicity for a period of six months. Vapour was also good for four months. There was no difference in the toxicity of the deposits on different types of mud.

Dieldrin. A 100 mg/sq.ft. deposit showed good contact toxicity for 15 months on all materials, and fair vapour toxicity for 15 months. There is no difference in the activity of Dieldrin on the different types of mud. However, there is a slackening of vapour toxicity, coincident with the drier months of the year. Vapour toxicity in Dieldrin resumes its former intensity (in mud) when the relative humidity picks up.

55/36 NEW METHOD OF RECOVERING SUPERFICIAL DDT OR OTHER INSECTICIDES FROM SPRAYED SURFACES

M.E. ALESSANDRINI. Istituto Superiore di Sanità, Rome  
WHO/Insecticides/39. 5 July 1955.

The paper describes a method of recovering residual deposits of insecticides from sprayed surfaces, using a technique similar to that described by Barlow (WHO/Insecticides/22, December 1953).

The method described consists in spreading a very thin layer of a type of silicone on a strip of parchment paper and in pressing the latter hard against the surface from which it is desired to recover the insecticide. Where DDT is concerned, this is dissolved from the treated paper with acetone and the DDT content of the extract is determined either by the Alessandrini colour matching method, for field work, or the Schechter/Haller method may be employed if accurate results are required.

In practice, it is recommended that strips of parchment paper are cut measuring 10 sq. cm. (2 x 5) or squares measuring 25 sq. cm. (5 x 5). Although the size and shape of the paper can be varied, it is preferable to use a number of smaller pieces applied at different points, rather than one large piece of paper, applied at one spot.

On these squares or strips a very thin layer of silicone is spread. The product actually tested was the Dow Corning Silicone Lubricant (High Vacuum Grease). Spreading the silicone with the finger is possible, but the utmost care must be taken to ensure that the product

is spread evenly, and the slightest excess should be removed. The insecticide is recovered from the sprayed surface by pressing the prepared surface of the paper as hard as possible against the surface. The pressure can be applied with a small metal roller or simply by repeatedly pressing on the paper in all directions with the fleshy part of a finger or fingernail.

In the case of a particularly hard surface, a second strip of the same dimensions may be applied at the same point, so as to remove any small quantities which may remain.

On each of the strips used for the removal of the DDT, held at the end of a small pair of surgical pincers, 10-25 ml. of acetone is dropped slowly, using a pipette, and collected in a small beaker. The acetone extracts are evaporated to a small bulk, and then decanted into a 100 ml standard flask. The strips are finally immersed for a few minutes in fresh acetone, which is added to the flask, and then made up to volume with more acetone. After mixing, an aliquot is taken and the analysis completed using either the Alessandrini or the Schechter/Haller method.

This technique is claimed to be an improvement on the "Sellotape" method used by Barlow, which was not able to be used with the Alessandrini or the Schechter/Haller procedures, owing to the extracted organic matter from the "Sellotape" interfering with the colour development used in these methods.

55/37 STUDIES ON DDT-DEHYDROCHLORINASE ACTIVITY IN RESISTANT HOUSEFLIES AND MOSQUITOES. (Reproduced whole).

A.W.A. BROWN. (August 1955) WHO/Insecticides/40.

The presence of this DDT-detoxifying enzyme has been assessed by directly measuring DDE production by its U-V spectrophotometric absorption (5). The dehydrochlorinase activity of homogenates and acetone powders obtained from a DDT-resistant and a Diland-resistant strain of houseflies was first determined. Attempts were made then to demonstrate dehydrochlorinase activity in similar preparations taken from larvae of two DDT-resistant strains of Aedes mosquitos. The experience obtained in this short-term series of studies is reported herewith as a contribution to others who may be investigating the nature of DDT-resistance in mosquitoes.

## Methods

Homogenates were prepared by suspending 1.25 g of material (75 adult flies or 250-400 mosquito larvae) in 25 cc of ice-cold water and homogenizing a Waring blender for one minute. The suspension was centrifuged at 1000 r.p.m. for two minutes, and the supernatant was filtered through gauze.

Acetone powders were made by homogenizing the insect material for one minute in 10 parts of acetone at  $-5^{\circ}\text{C}$ . After rapid filtering through No. 1 Whatman filter paper it was washed with 10 parts of ether, and while still wet with ether it was dried in a vacuum desiccator. The material dries into a cake which can later be cut up and pulverized. In preparing an enzyme suspension, 1 g of the dry powder was suspended in 15 cc water, lightly centrifuged, and filtered through gauze.

Digests were prepared by adding 2 cc of the suspension, obtained from homogenates or acetone powders, to 0.5 cc of 0.137 M. phosphate buffer (at pH 7.4) in Warburg side-arm flasks; 0.5 cc of 0.018M glutathione in phosphate buffer was placed in the side-arm. Each flask contained 200 micrograms of DDT, added in one of two ways: (1) absorbed on 25 mg of tiny glass beads (50-60 microns diameter) by evaporating its acetone solution in an air-stream, or (2) dissolved in 15 cu. mm of ethanol and introduced by micro-pipette. The digests were run for three hours at  $37^{\circ}\text{C}$  under nitrogen, the reaction being commenced by tipping in the glutathione from the side-arm, and stopped by adding 3 cc of concentrated sulphuric acid.

The products were extracted in 15 cc of cyclohexane, and were assayed in the Beckman DU spectrophotometer with the U-V attachment. The amount of DDE was read at a slit-width of 0.9 and a wavelength of 260 millimicrons ( $\lambda$ ), and that of DDE plus DDT was read at a slit-width of 1.4 and a wavelength of 241 millimicrons. Under these conditions, the absorbances produced by DDE at a concentration of 10 microgram/cc were 0.550 at 241 millimicrons, and 0.510 at 260 millimicrons, and those of DDT were 0.450 at 241 millimicrons and 0.001 at 260 millimicrons.<sup>(3)</sup> Results were calculated on the assumption of a two-component system<sup>(3)</sup>.

When a homogenate or acetone powder suspension was tested, four sample digests were employed; two served as experimental digests, one as a control lacking the substrate DDT, and one as a control in which the glutathione was withheld until the end of the reaction period.

Mosquito larvae were also assessed for DDE production in vivo. They were exposed to DDT for 24 hours in pans containing 1 litre of tap-water. The larvae were removed by filtering through cheese cloth, and washed with distilled water. They were dried on filter paper and

ground in a mortar with sea-sand and sodium sulphate. The preparation was extracted with carbon tetrachloride and passed through filter-paper. The Schechter-Haller assessments were made after purification in a Davidow celite column.

#### Notes on Methods

The following observations gained from experience are offered as a supplement to the original excellent description of the method: (5)

Glutathione solutions should be freshly prepared for optimum results; after two weeks they may no longer activate the enzyme. Glutathione solution alone, in absence of the enzyme, will not induce conversion of DDT to DDE.

Concentrated sulphuric acid is necessary to aid the partition of DDT and DDE into cyclohexane; if the digests are stopped by other means, the partition is only 40% of that obtained with sulphuric acid.

Complete extraction with cyclohexane requires vigorous shaking. When the Warburg flasks have centre-wells and thus prohibit extraction in the flasks themselves, the contents should be transferred to 100-cc round-bottomed flasks and followed by three 5-cc lots of cyclohexane. Smaller containers and horizontal shaking often produced stable emulsions. The larger 100-cc flasks and vertical shaking never gave stable emulsions. The average recoveries for 30-60 minutes' shaking were 76-80%; for 2 hours' shaking, 86-87%; and for 2 hours' shaking followed by vigorous hand-shaking for one minute, 96-100% recovery was obtained.

Very great care is necessary to avoid impurities that produce U-V absorption. Residues of stopcock grease on the necks of the Warburg flasks can give absorbances of approximately .030 at both wavelengths. The introduction of DDT in 15 cu. mm of ethanol added .030 absorbance at 260 millimicrons. Pouring the cyclohexane extract into intermediate containers instead of directly into the cuvettes can induce discrepancies between duplicates of approximately .030 absorbance at both wavelengths. The biological material in housefly homogenates and powders adds approximately .090 absorbance at 260 millimicrons, and .180 at 241 millimicrons (homogenates only). With mosquito homogenates and powders, tyrosinase so darkens the suspensions that approximately .250 absorbance is added at 260 millimicrons; this was reduced to less than .040 by pre-treating the suspension water with nitrogen gas, and preparing the digests as quickly as possible.

The variation between the readings of the two experimental flasks was moderate. At 241 millimicrons, where the average absorbance was 0.664, the average discrepancy between duplicates was .055. At 260

millimicrons, where the average of the various absorbances obtained was .210, the average discrepancy between duplicates was .036.

## Results

### (a) Musca domestica

Two strains were investigated: (1) DDT-45, bred at Savannah by submitting the NAIDM strain to DDT pressure for six years, and (2) Dilan, produced at Savannah by dilan pressure on the NAIDM strain for two years and never submitted to DDT. Both strains showed an m.l.d. in excess of 50 micrograms per fly when DDT was topically applied. The weights of three-day-old adults (mixed sexes) of these strains were as follows: DDT-45, 62 flies/gm; Dilan 60 flies/gm. Approximately 2.2 gm of acetone powder were obtained from every 10 g. of flies.

The following are the micrograms of DDE produced by 2 cc of enzyme suspension from 200 micrograms DDT (added in ethanol for homogenates, and on glass beads for acetone powders); they represent the average of the two experimental digests, corrected by the controls, run for three hours.

|               | DDT-45 strain  |             |               | Dilan Strain   |             |               |
|---------------|----------------|-------------|---------------|----------------|-------------|---------------|
|               | DDE re-covered | % Re-covery | DDE Pro-duced | DDE Re-covered | % Re-covery | DDE Pro-duced |
| Homogenates   | 74             | 76          | 98            | 76             | 76          | 100           |
| Powder, old   | 43             | 82          | 52            | 32             | 82          | 39            |
| Powder, fresh | 49             | 77          | 64            | 23             | 77          | 30            |

It will be seen that the production of DDE by the homogenates is considerable, indicating the validity of the methods employed. The 2 cc of enzyme suspension is equivalent to six flies, as in the method originally reported,<sup>(5)</sup> in which a yield of 51-60 micrograms of DDE was obtained when material from the DDT-45 strain was incubated for 2-4 hours.

With the acetone powders, where 2 cc of enzyme preparation is equivalent to 37 flies, the DDE production is less. The powder designated as "old" had been prepared two weeks earlier, without the special precaution of adding the ether before the acetone had completely passed the filter; it therefore needed resuspending and rehomogenizing and was dark red in colour. It proved to produce no less DDE than a fresh powder, made with all the precautions satisfied and pale pink in colour.

It is interesting to note that the Dilan strain, never exposed to DDT, showed a dehydrochlorinase activity approaching that of the DDT strain. The duplicate digests of the Dilan strain showed notably greater discrepancies than those of the DDT strain. When the value for DDE obtained by the U-V method was checked by the Schechter-Haller method, one of the duplicate samples for Dilan strain, powder, fresh, showed 30 micrograms, as compared with 24 micrograms for U-V.

(b) Aedes taeniorhynchus and sollicitans

Fourth-stage larvae of these salt-marsh mosquitos, consisting of A. taeniorhynchus admixed with A. sollicitans, were obtained from (a) the Oatland Island marshes, Savannah, Georgia, where DDT had never been used, and (b) Cocoa Beach, Florida, where DDT-resistance was reported in 1951 and which has subsequently been liberally treated with lindane, dieldrin, and heptachlor. The weight of the larvae was 200/gm.

The m.l.d. for the Savannah strain, determined by exposing fourth-stage larvae in pans (20 larvae per litre) for 24 hours, was 0.003 p.p.m. DDT; that of the Cocoa Beach strain was 0.04 p.p.m. DDT. This latter result is comparable with the results obtained with A. taeniorhynchus in 1950,<sup>(2)</sup> where the mortality after 48 hours exposure to 0.01 p.p.m. was 16% for Cocoa Beach larvae, and 85% for larvae from untreated areas.

The 140 larvae of the Cocoa Beach strain used in the toxicity test were found to contain 73.3 micrograms DDT and 15.9 micrograms DDE, the DDE/DDT ratio thus being 17.8%. An equal number of Savannah strain larvae exposed to 0.005 p.p.m. for 24 hours were found to carry 5.6 micrograms DDT and 2.4 micrograms DDE; the value for DDE being obtained by subtracting the (very small) absorbance of untreated larvae from that of treated larvae, if of questionable significance.

When the enzyme suspensions of these mosquitos were tested, the glutathione control could not be used since considerable tyroinase darkening developed during incubation. By using instead the control without substrate, where the absorbance was very low, the figures obtained by subtraction show the following DDE production, in micrograms,

|                     | <u>Cocoa Beach</u> | <u>Savannah</u> |
|---------------------|--------------------|-----------------|
| Powder, fresh       | 5                  | 9               |
| Powder, old         | -                  | 6               |
| Homogenate, beads   | 4                  | -               |
| Homogenate, ethanol | 3                  | 3               |

The samples for the fresh powder were assayed also by the Schechter-Haller method; the figures for DDE were 5.5 and 2.5 micrograms respectively, which cannot be taken as significant. The entire set of figures obtained by the U-V absorption method cannot be taken as indicating a significant production of DDE by enzyme suspensions of these mosquitos.

(c) Aedes aegypti

Fourth-stage larvae were obtained from Communicable Disease Center stocks of the following strains; (a) CD strain, obtained from Camp Detrick, Maryland, and having normal susceptibility; (b) Trinidad strain, a resistant population recently discovered in the villages of El Socorro and Aranguez.<sup>(1)</sup> The m.l.d. for the CD strain was 0.004 p.p.m. and for the Trinidad strain it proved to be 2.0 p.p.m.; this latter figure is comparable to the m.l.d. of 9 p.p.m. when DDT emulsion was used as the means of test.<sup>(1)</sup>

When larvae of the CD strain were exposed to 0.003 p.p.m. for 24 hours, they were found to contain two micrograms of DDT and 1.3 micrograms of DDE per 200 larvae (as corrected by a similar amount of unexposed larvae). When the resistant Trinidad strain were exposed to 1 p.p.m. for 24 hours in three 1-litre pans, the 150 larvae employed were found to carry 1553 micrograms of DDT and 149.3 micrograms of DDE. This uptake of DDT, which was retained with the larvae although they were repeatedly washed with distilled water, represents slightly over one-half of the 3 mg of DDT applied in the three pans.

Then homogenates of these larvae were incubated with 200 micrograms of DDT, the following values for DDE production were obtained by subtracting the absorbance at 260 millimicrons of the controls without substrate from the experiment digests:

|                             | <u>Trinidad</u> | <u>CD</u> |
|-----------------------------|-----------------|-----------|
| DDT on glass beads          | 0               | 7         |
| DDT in ethanol              |                 |           |
| Enzyme conc.'s 1.25 g/25 cc | 0               | 0         |
| " " 1.78 g/25 cc            | 0               | -         |
| " " 1.6 g/15 cc             | 0               | 0         |

It may be seen that no DDE was produced by these homogenates. When the enzyme concentration of 1.25 g/25 cc (the level used with houseflies) was increased by 2.7 times to a level of 1.6 g/15 cc, the DDE production was also negative.

The 2 cc of homogenate at the highest concentration is equivalent to 63 larvae (the weight of the larvae being 280/gm), and produced no DDE in vitro. Yet 150 larvae in vivo produced 149 micrograms of DDE,

roughly 1 microgram per larva in 24 hours. These resistant Aedes aegypti larvae produce DDE at a rate comparable to the DDT-45 strain of houseflies; since one fly will produce 1.47 micrograms of DDE eight hours after topical application of DDT, (4) the conversion rate is 4.5 micrograms per 24 hours for an adult fly weighing 4.5 times as much as a mosquito larva.

It is therefore clear that, whereas the DDT-resistant Trinidad strain of Aedes aegypti can produce DDE in viro at rates comparable to DDT-resistant houseflies, their homogenates cannot effect the conversion in vitro under conditions in which housefly homogenates can do it successfully. This would suggest that the conditions (pH, activator, etc.) required by the dehydrochlorinase enzyme of resistant mosquitos must be different from those required by resistant houseflies.

### Summary and Conclusions

1. DDT-dehydrochlorinase activity in vitro was found in a Dilan-resistant strain of houseflies, never exposed to DDT but resistant to it, in amounts comparable to those in a DDT-resistant strain.
2. DDT-dehydrochlorinase activity in vitro could not be demonstrated in larvae of resistant Aedes aegypti and salt-marsh Aedes. These larvae however readily produced DDE in vivo, at rates comparable to resistant houseflies.
3. The possibility that mosquito dehydrochlorinase requires different conditions from those applicable to housefly dhydrochlorinase should be investigated.

### Acknowledgments

The author wishes to thank: Dr. S.W. Simmons, Chief, Technology Branch, and Mr. K.D. Quarterman, Chief, Technical Development Laboratories, Savannah, Georgia, for providing the opportunity to work on this problem; Dr. A.S. Perry, for offering the facilities of his laboratory and for his active help and advice; and Dr. R.W. Fay, for matters pertaining to the biological material. Resistant mosquitos were obtained through the kindness of Dr. Carroll N. Smith, U.S. Department of Agriculture, Florida, and of Dr. A.A. Feat, Director of Medical Services, Trinidad.

### References

- (1) Kellette, F.R.S., Gillette, H.P.S. & Feat, A.A. (1954) In: Malaria Div., Health Dept., Government of Trinidad, Annual Report.
- (2) King, W.V. (1950) J.econ.Ent., 43, 527.
- (3) Perry, A.S. & Hoskins, W.M. (1951) J.econ.Ent., 44, 850.
- (4) Perry, A.S., Fay, R.W. & Buckner, A.J. (1953) J.econ. Ent., 46, 972.
- (5) Sternburg, J., Kearns, C.W. & Moorefield, H. (1954). J.Agr. Food Chem. 2, 1125.

Significant developments reported during the period under review are as follows:-

### Repellents

Repellents are usually compared on the basis of the length of time they prevent mosquito bites when the treated skin is protected from rubbing. In actual use it seems probable that much of the repellent is rubbed off rather than lost by evaporation or absorption. To determine whether repellents retained their same relative effectiveness with regard to rubbing and aging, a technique was developed to determine the number of times a repellent-treated arm could be rubbed with a wiping tissue before receiving mosquito bites. A new repellent, diethyltoluamide, withstood an average of 58 wipes, 2-ethyl-1,3-hexanediol withstood 14, dimethyl phthalate 1, and mixture M-2020 10. In aging tests diethyltoluamide has given protection two or three times as long as M-2020, but it was about six times as resistant to wiping. Mixtures containing diethyltoluamide and the other repellents were not much more resistant to wiping than the other repellents alone.

Diethyltoluamide is a highly effective repellent for treatment of the clothing as well as the skin, and tests were made to determine whether a single aerosol formulation would serve both purposes. Equal amounts of repellent dispensed from an aerosol bomb and a shaker bottle gave equal periods of protection against mosquitoes when applied to the skin, and stockings treated with the aerosol were effective longer than stockings impregnated with the repellent in a volatile solvent.

Diethyltoluamide, a new repellent which has been highly effective against deer flies, stable flies, ticks, fleas, chiggers, and six species of mosquitoes, gave protection 25 percent longer than the standard repellent, M-2020, in tests against sand flies, Culicoides canithorax Hoff.

Previous tests indicated that the residual effectiveness of a homologous series of cyclohexane aliphatic acids increased with the number of carbons in the structural chain up to a certain length, and then decreased. More extensive tests were conducted to determine whether the acids showed the same relative effectiveness in initial and residual repellency.

The acids and their structural formulas were:

|                            |                         |
|----------------------------|-------------------------|
| Cyclohexanecarboxylic acid | $C_6H_{11}COOH$         |
| Cyclohexaneacetic acid     | $C_6H_{11}CH_2COOH$     |
| Cyclohexanepropionic acid  | $C_6H_{11}(CH_2)_2COOH$ |
| Cyclohexanebutyric acid    | $C_6H_{11}(CH_2)_3COOH$ |
| Cyclohexanevaleric acid    | $C_6H_{11}(CH_2)_4COOH$ |
| Cyclohexanehexanoic acid   | $C_6H_{11}(CH_2)_5COOH$ |

Increasing the length of the chain by the insertion of 1, 2, or 3 carbons, progressively increased the initial effectiveness of the repellent, whereas the addition of 4 and 5 carbons resulted in a decrease of effectiveness. The minimum dosage that reduced the number of bites through a treated stocking to less than one was 0.25 gram for cyclohexanecarboxylic acid, 0.20 gram for cyclohexaneacetic acid, 0.15 gram for cyclohexanepropionic acid, and 0.10 gram for cyclohexanebutyric acid. Cyclohexanevaleric acid did not provide this degree of protection with any concentration, and the average number of bites ranged from 4 to more than 7 with dosages of 0.10 to 0.60 gram. With dosages of 0.50 to 2.0 grams of cyclohexanehexanoic acid, the number of bites ranged from 4 to more than 9.

In residual repellence at twice the minimum concentration that was effective initially, the first three repellents in the series also showed progressively increasing effectiveness. The fourth member of the series, cyclohexanebutyric acid, showed greater residual effectiveness to the 10th bite, but not to the first bite, than the acids with shorter chains. Cyclohexanevaleric acid also provided a long period of protection to the 10th bite, although it was not completely effective initially.

#### Louse Control

Fifteen of the better synergists for pyrethrins were tested as synergists for cyclothrin against body lice. The alpha-allylpiperonyl, the alpha-propylpiperonyl, the 4-(3,4-methylenedioxyphenyl)-sec-butyl, and the alpha-isopropylpiperonyl esters of chrysanthemumic acid, and the alpha-allylpiperonyl ester of fencholic acid were the most effective synergists for cyclothrin, each giving at least 85-percent knockdown and kill through the 35th day after treatment. All were superior to sulfoxide. However, pyrethrins with sulfoxide was more effective than cyclothrin with any synergist, and allethrin with sulfoxide was slightly less effective than cyclothrin with some of its better synergists.

Sleeve tests were conducted to evaluate talc and pyrophyllite as carriers in louse powders containing 1 percent of lindane or DDT. The bottoms of the treated sleeves worn by the research subjects were not taped to the arms or legs during the 3-4 day intervals between exposures of lice, which permitted more rapid loss of the powder than normally occurs in sleeve tests. Powders containing pyrophyllite were 10 to 15 percent more effective than those containing talc after more than 3 days of wear.

#### Control of House Flies

Sugar baits containing 0.05 to 1.0 percent of DDVP or the ethyl analog of DDVP were highly effective against natural populations of house flies in unscreened dairy barns, producing reductions of 92 to

97 percent 10 minutes after treatment and reductions of 79 to 99 percent 4 hours after treatment. There was considerable variation in the effectiveness of the two insecticides 24 hours after treatment, but there was no consistent difference between them.

Laboratory tests were conducted with five samples of granular fly baits that had aged for periods ranging from 1 to 9 months to determine whether the older samples had lost effectiveness. All the baits contained 1 percent malathion as the insecticide and shell as the carrier. However, the samples were not identical, as the oil content ranged from 1 to 2 percent, the food content from 4 to 16 percent, and the carrier from 84 to 94 percent. The possibility of an alkaline reaction of the shells resulting in deterioration of the malathion prompted the investigation. Standard dry sugar bait containing 1 percent malathion was included for comparison. There was no correlation between the age of the sample and the degree of effectiveness. In general, the baits containing the greater percentages of food were slightly more effective than those with less food.

#### Control of Fleas

Emulsions containing 1 or 2 percent of malathion were tested against natural populations of cat fleas in dooryards. A power sprayer was used to treat infested areas ranging from 2,000 to 10,000 square feet. One gallon of 2-percent emulsion per 1,000 square feet was 99 percent effective for 4 weeks, and was considerably more effective than 0.5 gallon, which produced 78 to 94 percent reduction for 2 weeks and 55 percent reduction after 4 weeks. One gallon of 1-percent emulsion was 97 to 88 percent effective for 1 week but was only 61 percent effective after 2 weeks.

#### Mosquito Larvicides

Tests against Anopheles quadrimaculatus larvae were run with aged water solutions of Bayer L 13/59 and Shell OS 2046 (1-carbomethoxy-1-propen-2-yl dimethyl ester of phosphoric acid) to determine whether different types of water or exposure to sunlight would decompose the insecticides. The chemicals were dissolved in distilled, stagnant, or tap water at the rate of 10 p.p.m. Soil collected near the laboratory was added to the samples prepared with tap water. Outdoor exposure to sunlight for 5 weeks almost destroyed the toxicity of Shell OS-2046 and had a deleterious effect on Bayer L 13/59. These results are in disagreement with those reported last quarter, when no decomposition was apparent in 4 weeks. The warmer weather and stronger sunshine during this second series probably were responsible for the difference observed. The stagnant water and the tap water with soil caused a greater loss in the toxicity of Bayer L 13/59 than did distilled water.

Two compounds (3-(N-hydroxycarbamoyl)-methyl pyridinium bromide and pentamethylenebis (trimethyl ammonium bromide) that have the property of reducing mammalian cholinesterase inhibition by phosphates were tested to determine whether they also reduce the toxicity of phosphate insecticides to mosquito larvae. Malathion, parathion and EPN were tested alone and in combinations containing 1 part of phosphate plus 10 parts of the anti-cholinesterase-inhibitor against fourth instar larvae of Anopheles quadrimaculatus. Neither compound reduced the effectiveness of any of the insecticides. If these results are borne out in tests against other insects, the compounds would be useful in reducing the hazards of phosphorus insecticides without affecting their efficiency.

A series of field tests was made in the vicinity of Visalia and Tulare, Calif., in cooperation with the California Bureau of Vector Control, to evaluate Bayer L 13/59 and Shell OS 2046 as water-soluble larvicides for mosquito control in irrigated pastures. The most abundant species of mosquito present was Aedes nigromaculis (Ludl.). Bayer L 13/59 at 1 and 3 p.p.m. and Shell OS 2046 at 1 p.p.m. gave 99.9 to 100 percent control. Incomplete control (74 percent) was obtained with Bayer L 13/59 at 0.1 p.p.m. Some of the plots treated with Bayer L 13/59 at 3 and 1 p.p.m. were dried and reflooded with untreated water, and all became heavily infested.

Water samples removed from the lower end of each plot the second day after the insecticides were applied gave 100 percent kill of Aedes larvae exposed in them for 24 hours. Samples from plots one-half mile long treated with Bayer L 13/59 at 1 p.p.m. caused complete knockdown in 2 to 3 hours, as did samples from shorter plots. Samples from plots treated with Bayer L 13/59 at 0.1 p.p.m. gave complete knockdown in 16 to 24 hours. The samples collected after 2 days were still 100 percent effective after 8 days, whereas samples collected after the water had stood on the fields for 8 days were ineffective.

Eleven compounds that proved to be the most effective granular toxicants in laboratory tests were tested in roadside ditches infested with larvae of Anopheles quadrimaculatus and A. crucians. Attapulgate granules containing 1 percent of parathion, EPN, and Bayer 21/199 were the most effective, producing 88 to 99 percent mortality at 0.01 pound per acre. TDE, DFDT, Diazinon, and AM. Cyanamid Nos. 4124, 12008, and 12009 caused kills ranging between 92 and 99 percent at 0.1 pound per acre, but DDVP and its ethyl homolog were not highly effective at this dosage.

#### Black Fly Larvicides

In cooperation with the Animal Disease and Parasite Research Branch and the Clemson Agricultural College, three tests were conducted in the Ridgeland, S.C., area to evaluate the effectiveness of aerial applications

of DDT sprays and dieldrin granules against black flies. A solution containing 5 percent of DDT in kerosene was applied to plots that were 11 and 14 square miles in area at the rate of 0.033 pound of DDT per acre. Bentonite-attapulgitic granules containing 7 percent of dieldrin were applied to 1 square mile at a dosage of 0.04 pound of dieldrin per acre. The species of black flies involved included Simulium congreanarum, S. tuberosum, S. venustum, S. slossonae, S. decorum, and Cnephia pecuarum. The dieldrin granules gave 100 percent control for 2 weeks and 94 to 98 percent control through 4 weeks. In the large plot the DDT spray gave better than 99 percent control for 2 weeks and 68 to 72 percent control after 3 or 4 weeks. In the small DDT plot the control rose gradually to 95 percent after 1 week, and dropped to 87-88 percent during the third and fourth weeks. After the fourth week a drought reduced the water level and larval breeding in all streams.

### Control of Fabric Insects

Military trousers packed in a wooden box containing 19 grams of lindane crystals were practically free of all insect damage after 2 $\frac{1}{2}$  year' storage in a heavily infested room. Under the same conditions 11 of 15 pairs of trousers packed in a box containing 170 grams of naphthalene were damaged by insects. All trousers packed in an untreated box were heavily damaged. The lindane crystals produced 100 percent mortality to the insects which entered the box containing the insecticide, whereas a large number of insects entered and remained alive in the box containing naphthalene crystals. After the 2 $\frac{1}{2}$ -year period nearly half the lindane crystals originally placed in the box was still present but all the naphthalene had completely volatilized. These results strongly indicate that lindane at 19 grams per box will give at least twice the duration of protection as naphthalene at 170 grams (6 ounces) per box.

## REVIEW

### SURFACTANTS FOR INSECTICIDE FORMULATION : A REVIEW

G.W. WOOD. Colonial Pesticides Information Service. Aug. 1955.

The use of surface-active agents in the formulation of insecticides is of course well-established, and until a few years ago, the available surface-active materials were well-defined compounds, which in many cases had been in use over a considerable time.

However, as in many other fields, the rate of development of surface-active agents in the past decade has been great, and the present position in this field is one of complexity, with an abundance of various compounds which are continually increasing, each new surfactant discovered leading to many more compounds with similar properties.

In general terms, substances which are positively adsorbed on a liquid interface are referred to as surface active. Martin<sup>(1)</sup> discusses the various requirements of surface-active materials in relation to their use in fungicide and insecticide formulation. The related manifestations of surface activity are lowering of surface tension, which is often referred to as "wetting"; reduction of interfacial tension and extension of liquids over solid surfaces, best described as "spreading"; increase in wetting power, whereby penetration into porous solids is affected; emulsification, whereby intimate mixtures of two immiscible liquids are formed; deflocculation, or dispersing power, in which agglomerates of solid particles are broken up and suspended in a liquid.

As may be expected, these aspects of surface activity are closely related, and many surface active materials possess properties which enable them to be used for promoting more than one type of surface-activity.

#### Emulsifying Agents

The fundamental principles of emulsification have been studied by many workers, and several theories have been advanced regarding this subject.<sup>(2), (3), (4), (5), (6).</sup>

The orientation theory of Harkins and Langmuir postulates that emulsifying agents are substances that contain within one molecule a fatty group at one end and a polar group at the other. The emulsifier is oriented at the interface between oil and water in such a manner that the hydrocarbon part of the molecule is active in the surface of the oil droplet while the polar group touches the water phase.

Based on this theory, Harris(7) worked out the concept of the proper balance of hydrophilic and hydrophobic constituents in a surfactant, in order to make the compound effective.

More recently, a system has been introduced by the Atlas Powder Co.(8) which is designed to match the emulsifier with the particular function it is required to do, in the emulsion. This process, known as the HLB system is based on a hydrophile-lipophile balance, i.e. attraction for oil or water, each surfactant being given an empirical number to designate its HLB. Thus the lowest HLB values, i.e. the most lipophilic or "oil-loving" materials are water-in-oil emulsifiers, while the higher HLB values, (the most hydrophilic or "water-loving" materials) are oil-in-water emulsifiers and solubilising materials. Griffin(9) has described how HLB values may be determined experimentally, although the procedure is long and laborious. To overcome these difficulties, the same author has put forward a method(10) for calculating these values, using either analytical or composition data. Griffin considers that two conditions must be satisfied in choosing a surfactant for any desired formulation. First, the proper HLB or hydrophilic content of the surfactant must be used and secondly the proper chemical type of the surfactant must be chosen. By first determining the optimum HLB value and then selecting and testing a variety of chemical types at this particular value a large number of wrong trials can be eliminated. There is need however, for further work in this particular field to establish a rapid, more exact experimental procedure for observing and determining HLB values, and for classifying and correlating chemical types of surfactants.

Although the synthesis of these emulsifying agents is beyond the scope of this paper, it is of interest to note that the starting material for many of them is ethylene oxide, and commencing with a hydrophobic compound such as an alkyl phenol or a fatty acid, the surface-active properties of the resulting product can be varied, by altering the mole ratio of the reacting ethylene oxide.

In general terms, emulsifiers with a long polyoxyethylene chain are usually sufficiently soluble in aromatic solvents to permit of their use in the formulation of such toxicants as DDT, BHC, dieldrin, etc. On the other hand, emulsifiers of this type have very limited solubility in aliphatic solvents such as kerosene or spray oils with a high unsulphonated residue.

There are several ways of overcoming this drawback - by the use of coupling agents, such as glycols or glycol ethers or by taking advantage of the fact that often these emulsifiers are soluble in the solution of the toxicant in kerosene. These methods are utilised, for example, in many of the chlordane and toxaphene 4, 6 and 8 lb. per gallon concentrates, although if the concentration of the toxicant is reduced below 40%, the choice of emulsifying agents soluble in such systems again

becomes limited. Many aspects of the formulation of chlordane emulsifiable concentrates are discussed in a bulletin issued by Julius Hyman & Co., (11) which describes amongst other things, the preparation of "solubilized" chlordane emulsions, with chlordane virtually in colloidal solution. This method of formulation may have possibilities with other toxicants and could have many practical advantages.

For many purposes, mixtures of emulsifiers have been recommended (12). The blending of emulsifiers is tied up with the specific hydrophilic-hydrophobic ratio for each formulation.

Mayhew and Hyatt (13), have studied the variation in certain surface active properties of the homologous series of condensation products of nonyl phenol with increasing mole ratios of ethylene oxide. They found that a 45% toxaphene concentrate in kerosene with a 6-mole ethylene oxide/1-mole nonyl phenol ratio gave good emulsification, whereas in a 25% DDT concentrate in xylene, a 9.5 mole material gave the best results.

It should be borne in mind, that an emulsifier that gives excellent performance in one formulation often fails completely in a slightly different toxicant-solvent system, and this points to the virtue of testing new emulsifiers or blends with a given system, as the efficacy of the emulsifier is not always predictable.

Emulsifiers most commonly used with insecticidal sprays can be divided into two types - non-ionic and combinations of non-ionic and anionic. Non-ionic emulsifiers have found wide acceptance for two principal reasons - they are not affected by wide variations in water hardness, and formulated products containing such emulsifiers normally have better storage stability than those containing anionic emulsifiers.

Anionic emulsifiers have the important property of producing low interfacial tension, which favours ease of emulsification and helps to produce small dispersed droplets. On account of their chemical reactivity, the anionic emulsifiers have the disadvantage of limited stability, when used alone in a system.

A combination of a non-ionic and anionic emulsifiers is better, in many respects, than either alone, since the combination acts through the combined stabilizing influence of surface charge and the presence of a protective agent. The mechanism which is at work here has been described by Jellinek (14), as that of a synergistic effect upon interfacial activity, and it is thought that mixed emulsifiers may lower interfacial tension below that of either one alone.

On the subject of specific methods of formulation, Chisholm (15) has discussed this topic in some detail, and describes methods and the factors involved for the selection of surface active agents and the

control of batch variations, as well as methods for the determination of the miscibility index for solvents, and mixtures of surfactants.

A series of typical pesticide emulsion formulations is given in the I.C.I. booklet<sup>(16)</sup> which also gives some details regarding manufacturing equipment involved.

Regarding the specific problem of pesticidal emulsions, Clayton<sup>(17)</sup> makes some very interesting general observations. Thus, it is thought that since a balance must be made between the pesticidal efficiency of a spray emulsion and its possible phytotoxicity to the plant<sup>(18)</sup>, it is important that the amount of oil which will be deposited on the surface is regulated.

Simplifying the behaviour of a spray, in order to obtain a qualitative picture, the following occurs:- droplets of water from a poorly wetting solution impinging on a hydrophobic surface will not spread to any extent, and with a limited amount of spray, the deposit will remain as discrete droplets, giving incomplete coverage of the surface; on evaporation of the water, the residue of toxic material will also be discontinuous. Larger amounts of spray will cause coalescence and bigger drops will form, which will run off inclined surfaces without leaving a residual liquid film. Addition of a surfactant to the water will reduce the air/liquid and solid/liquid interfacial tensions, so that the advancing contact angle will be smaller, resulting in a greater area of spread. If sufficient surfactant is present, the droplets will ultimately coalesce to give continuous areas, and if the receding contact angle is zero, a continuous film of liquid will remain, giving a uniform residue, after evaporation.

Various authors<sup>(19)</sup> have used contact angle measurements for the assessment of wetting and spreading properties, although a clear distinction between advancing and receding angles has not always been indicated.

Clayton<sup>(17)</sup> considers that laboratory tests of this type do not fully represent practical conditions since the kinetic energy of the spray droplets at impact is not taken into account; the sprayed surface is rarely smooth or plane, and the surface tension of a solution of a surface active compound alters with age, and in general, the surface tension decreases with ageing.

For wetting hairy leaf surfaces or fungal growth, penetration may be more important than spreading. Adam<sup>(20)</sup> discusses the principles of penetration, and Wilkes<sup>(21)</sup> reviews the physical properties of several surfactants possessing this property.

Fajans and Martin<sup>(22)</sup> pointed out that important factors in the performance of pesticidal sprays are the "initial retention" of spray

liquid, the "tenacity" of the deposit against agencies tending to remove it, and the "coverage" or uniformity of the deposit.

Both the tenacity and the initial retention of solid deposits are improved if hydrophilic colloids, or "stickers" are included in the formulation.

The wetting of insect cuticle and hairs by various liquids has been investigated by Pal(23), who showed that most insects are wetted by oils, but more readily by aliphatic than by aromatic hydrocarbons. Moore(24) has shown that the wetting power of a contact spray is directly related to its insecticidal efficiency; Cupples(25) determined the wetting power of a soap by its spreading coefficient on mineral oil, although the more usual test today is the Draves - Clarkson test(26) which measures the time necessary for a skein of cotton yarn to sink in a definite concentration of a wetting-agent in water at a definite temperature.

### Emulsion Stability

From the practical view point, the stability of the prepared emulsion is of major importance, since the performance of the toxicant in this form may be seriously impaired by one or other of the various instabilities which can occur in emulsions.

In the first place, the term "stability" is difficult to interpret, and it must be admitted that there is no satisfactory absolute definition of emulsion stability. Sutheim(27) suggests that for practical purposes, an emulsion is called stable when it remains without major changes for a period of time long enough to fulfill the purpose for which it is designed.

Clayton(17) considers that the ultimate stability of an emulsion depends on four principle factors, (a) fine dispersion of the globules, (b) a minimum difference in the densities of the two phases, (c) a viscous continuous phase, and (d) a stable film around the globules.

Of all the instabilities which can occur in emulsions, probably the most important from the insecticidal angle is that known as creaming. This is really the formation of a more concentrated emulsion layer, which contains a higher amount of the internal phase than the rest of the emulsion. The speed of creaming depends of course, on several variables including the specific gravity of the phases, viscosity of the external phase and globule size.

Sutheim(27) considers that creaming may also be due to a certain tackiness or adhesion of the interfacial film, and he suggests that creaming may be regarded as a special case of the more general phenomenon of sedimentation, which is more commonly associated with dispersions

of solids. Creaming can be retarded, according to Bennett(28), by agitation or by addition of a heavy or light material, to change the ratio of the specific gravities of the external and internal phases. Emulsions with large particles have a strong tendency to cream, optimum particle size is in the range 0.5 to 1.5  $\mu$ . The efficiency of various methods of preparation of emulsions and emulsifying agents is shown by different stabilities of the emulsions(29).

For some purposes, as in agricultural sprays, a quick-breaking emulsion is desirable. Martin(30) has pointed out that highly stable emulsions prepared with emulsifying agents of good wetting and spreading properties are, in general, less effective than less stable, quick-breaking emulsions. The quick-breaking property here, releases the active ingredient immediately after application; emulsions of this type usually contain an insufficient amount of emulsifying agent(31).

The fundamental difference between agricultural crop sprays and animal dips is largely one of stability(32). As has been stated above, for agricultural sprays, the emulsion should be quick-breaking to avoid excessive run-off from the leaf surface, and stability should merely be sufficient to ensure a uniform dosage of the toxicant, during application.

Sheep or cattle dips on the other hand, should be formulated to produce extremely stable emulsions. Addison(33) investigated the application of insecticides to sheep fleece, and found that the reaction of natural wool fleece with wetting agents changed sharply at a critical concentration near that for micelle formation in solution. Inactivation of cetyl pyridinium chloride by Scotch Blackface fleece showed that this was considerable even after one minute. Inactivation was due to grease and suint in the wool, since with clean fibres inactivation was relatively slight. Addison concluded that this inactivation was an important factor in the stability of animal emulsion dips and suspensions.

Sparr(34) found that the amount of toxaphene deposited on the hair of dipped cattle increased with the increase of particle size of the dispersed oil droplets.

### Testing Emulsions

The wide use of pesticides in emulsified form has, of course, lead to a very large number of testing techniques, designed to serve as a means of evaluating the properties which are required. In connection with the testing of emulsion characteristics, Suggitt(35) has suggested that for routine evaluation the simpler procedure of comparing the results obtained against a standard formulation is more rapid and meaningful than any absolute method.

Stability is tested by a variety of techniques. One method(36) depends on the creaming, or particle sedimentation of the emulsion; Merrill(37) determines the mechanical stability of emulsions by measuring the rate of separation of the internal phase under a constant centrifugal force. The reciprocal of the initial rate of separation at a constant centrifuge speed has been taken as a quantitative index of the mechanical stability of the emulsion, and the method can be applied to both water in oil and oil in water systems.

Griffin(38) has described a method which is based on the visual observation of the creaming rate, using special apparatus which facilitates the comparison of a large number of emulsions under standardized illumination.

Thus emulsions under use conditions may be evaluated, the technique being sufficiently simple for non-technical personnel to handle, with reliable results.

In a later paper, by Behrens(39) and Griffin, this method of testing has been used to study the many variables which can be encountered in connection with emulsions. The conclusions presented here showed that the preparation of the test emulsion was critical, with the amount and vigour of agitation, test temperature, and mode of addition and ratio of ingredients influencing results. Temperature was not found to affect emulsions stored at 25°C to 30°C, but at temperatures between 35°C to 40°C definite changes in stability occurred.

Another factor of importance is the nature of the dilution water. In America it is a common practice to use a number of standard waters of definite hardness in laboratory tests. The total hardness of these waters is in the range 290-340 ppm. expressed as calcium carbonate. The standard hard water, specified by the World Health Organization(40), is designed to provide a hardness of 342 ppm. as calcium carbonate, and this water figures in all appropriate specifications.

A method(41) based on the rate of change of density of the emulsion, using a hydrometer has been suggested. This method is really only suitable for heavier than water systems, but a hydrostatic balance method would probably suffice for lighter than water systems.

Pearce(41) has described a simple apparatus which can be used for evaluating both emulsion stability and suspensibility of wettable powders. This apparatus, which is very similar to that described by Griffin above, is arranged so that the test emulsions may be agitated by rotation on the test rack. Pearce draws attention to the fact that where dilute emulsions containing 1% or less of oil phase are evaluated, variable and erratic results are obtained when there is a delay between the introduction of the emulsifiable concentrate and agitation of the

water. It is suggested that this may be due to extraction of part of the emulsifying agent by the water before agitation.

Kelly(43) describes a method for the evaluation of the emulsion stability of herbicide formulations, which consists in the visual examination of the settled cream, using ASTM settling tubes.

The majority of the test methods which have been mentioned are of course directly related to the performance of the final diluted emulsifiable concentrate and in this respect are realistic, in relating the testing procedure with the use-requirements.

It does seem possible however, that the possibilities of accelerated test methods could be applied to the testing of emulsion stability, and indeed have been suggested(44).

The separation tendency of an emulsion can be gauged by such tests as (a) oven storage, (b) vibration, (c) freeze-thaw and (d) aeration. (a) can be carried out at 110°F-120°C. The World Health Organization Specifications(40) require this test to be carried out at 122°F  $\pm$  1.8°F and the concentrate is stored for 1 week at this temperature. (b) is best carried out using a travelometer. (c) one complete freeze-thaw cycle followed by gentle shaking to obtain a good condition may be regarded as satisfactory. (d) the average emulsion is highly sensitive to aeration, and air blowing usually breaks an emulsion in a very short time. Tests (b), (c) and (d) are of course, carried out on the diluted emulsion, while test (a) is carried out on the concentrate, which is subsequently diluted, and the emulsion examined for any deterioration in stability.

It is the inherent property of practically all formulated solutions of chlorinated toxicants to slowly liberate hydrochloric acid in storage, and this acid tends to deactivate emulsifiers. This deterioration is hastened by high temperatures, and drums containing insecticidal formulations should be stored in as cool a place as is possible, away from the direct rays of the sun.

Corrosion of the drums can be reduced by the use of suitable anti-corrosive linings, and most manufacturers ensure that the containers used for insecticidal formulations are adequate in this respect.

A commonly used method of suppressing acid accumulation is to add a hydrochloric acid scavenger which will absorb the acid more quickly and more strongly than does the emulsifier. Epichlorohydrin, at a concentration of 0.3% to 0.5% is commonly used for this purpose, and is recommended for use in the rehabilitation of aldrin and dieldrin emulsifiable concentrates, where the emulsifiers have broken down in storage(45).

Low temperature studies should include observations for any liquid phase separation of emulsifier or toxicant, since this type of instability can seriously affect the ultimate performance of the product.

The problem of successfully formulating an emulsifiable concentrate is more or less complicated by several factors. Thus, the nature of the application, and the degree of latitude which can be permitted as regards performance are important points to be considered. Depending upon how much information can be obtained regarding the behaviour of the selected toxicants, coupled with the availability of suitable solvents, and the extent of available data concerning the surfactants which can be used, all have to be taken into consideration before worth-while combinations can be formulated.

Physical and chemical factors can be correlated between field and laboratory reasonably well, but field evaluation of biological factors cannot be adequately substituted by any other means.

#### References

- (1) MARTIN, H. (1948). "Scientific Principles of Plant Protection". Arnold & Co. 76-103.
- (2) HARKINS, W. D. (1917). J.Am.Chem.Soc., 39, 541.
- (3) LANGMUIR, I. (1917). J.Am.Chem.Soc., 39, 1848.
- (4) LANGMUIR, I. (1925). Colloid Symposium Monograph. 3, 48.
- (5) FINKLE, P. (1923). J.Am.Chem.Soc., 45, 2780.
- (6) BROWN, G. L. (1951). Soap, 27, (7), 43-49.
- (7) HARRIS. (1933). U.S. Patent No. 1,917,250.
- (8) ATLAS POWDER CO. (1954). "Chemmunique". 2, 6, 2.
- (9) GRIFFIN, W. C. (1949). J.Soc.Cosmetic Chem., 1, 311-326.
- (10) " " (1954). J.Soc.Cosmetic Chem., 5, 4, 1-8.
- (11) J. HYMAN & CO. (1949). Technical Supplement No. 2B.
- (12) ANON. (1953). Soap, 29, 12, 179.
- (13) MAYHEW, R. L. (1952). J.Am.Oil Che.Soc., 29, 357-62.
- (14) JELLINEK, H. H. G. (1949). J.Soc.Chem.Ind., 68, 108.

- (15) CHISHOLM, R. D. (1951). Agr.Chem., 6, 11, 36.
- (16) I.C.I. LTD. "The Preparation of Emulsions" Leaflet No. 12.
- (17) CLAYTON'S "Emulsion and their technical Treatment".  
5th Ed. by C. G. Summer, 1954. J. & A. Churchill Ltd. 429-434.
- (18) YOUNG & MORRIS (1933). J.Agr.Res., 47, 505.  
YOUNG (1934). " " 49, 559.  
YOUNG (1935). Am.J.Bot., 22, 1.
- (19) O'KANE. (1930). New Hampshire Ag.Exp.Sta.Tech.Bull.39.  
" " " " " " " 40.  
" (1931). " " " " " " 46.  
" (1932). " " " " " " 48.  
" (1932). " " " " " " 51.  
WILCOXON & HARZELL (1931). Cont.Boyce Thompson Inst. 3, 1-12.  
EBELING. (1939). Higardia. 12, 665.
- (20) ADAM, N. K. (1948). Discuss.Faraday Soc. No.3. 5.
- (21) WILKES, B. G. (1937). Ind.Eng.Chem., 29, 1934.
- (22) FAJANS & MARTIN. (1937). J.Pomol.Hort.Sci., 15, 1.
- (23) PAL, R. (1950). Proc.8th Int.Cong.Ent.Stockholm. 1948, 936.
- (24) MOORE, W. J. (1918). J.econ.Ent., 11, 443.
- (25) CUPPLES, H. L. (1937). Ind.Eng.Chem., 924.
- (26) DRAVES. (1939). Am.Dyestuff Reprtr. 28, 425.
- (27) SUTHEIM, G. M. (1947). "Introduction to Emulsions".  
Chapman & Hall Ltd. p.120.
- (28) BENNETT, H. (1947). "Practical Emulsions". Chem.Publ.Co.  
New York. p.42.
- (29) PICK, L. (1928). Chem.Obzor. 3, 202.
- (30) MARTIN. (1937). "Wetting & Detergency". London. p.132.
- (31) ANON. "Technical Aspects of Emulsions". Chem.Publ.Co. New York.  
p.73.
- (32) SELZ, E. (1953). J.Agr.Food Chem., 1, 254-7.
- (33) ADDISON, C. C. (1952). J.Sci.Food Agr., 3, 7, 315-336.

- (34) SPARR, B. I. (1952). U.S.D.A. Bur.Ent.Plant Quar. E-849.  
November.
- (35) SUGGITT, J. W. (1954). Agr.Pesticide Tech.Soc.Macdonald College,  
Quebec, Canada, June 23.
- (36) BOCHKO. (1935). Masloboino Zhirovoe Delo. 11, 489.
- (37) MERRILL, R. C. (1943). Ind.Eng.Chem., Anal.Ed., 15, 743.
- (38) GRIFFIN, W. C. (1952). Anal.Chem., 24, 1076-8.  
" " (1952). Ag.Chem., 7, 3, 63.
- (39) BEHRENS, R. W. (1953). J.Agr.Food Chem., 1, 11, 721.
- (40) WORLD HEALTH ORGANIZATION (1955). Specifications for Pesticides  
and their Formulations. Geneva.
- (41) CSMA CITE ON EMULSION STABILITY. New York, 40th Annual Meeting,  
Dec. 1953, p.185.
- (42) PEARCE, D. A. (1955). Anal.Chem., 27, 1, 163-164.
- (43) KELLY, J. A. (1953). J.Agr.Food Chem., 1, 254-7.
- (44) ROHM & HAAS CO. (1952). "Triton Surface Agents".
- (45) SHELL CHEMICAL CORP. (1954). "Handbook of Aldrin, Dieldrin and  
Endrin Formulations". p.20.

SUPPLEMENT I

A LIST OF SURFACE-ACTIVE AGENTS MANUFACTURED IN THE UNITED KINGDOM (1955)

A. EMULSIFIERS AND EMULSION STABILISERS

| Trade Name | Composition and/or<br>Chemical Identity                                                                                   | Uses                                                                                                                              | Type                    | Manufacturer                                                                                          |
|------------|---------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------|-------------------------------------------------------------------------------------------------------|
| ARLACEL C* | Sorbitan<br>sesquioleate                                                                                                  | General purpose<br>emulsifier                                                                                                     | non-ionic               | Honeywill-Atlas<br>Ltd.,<br>Devonshire House,<br>Mayfair Place,<br>Piccadilly, W.1.                   |
| ARLACEL 83 | Sorbitan<br>sesquioleate<br>light coloured                                                                                |                                                                                                                                   |                         |                                                                                                       |
| CASA 88    | Mixture of saponi-<br>fied amino com-<br>pounds, 100% active                                                              | General pesticide<br>formulation.<br>Soluble in water,<br>white spirit,<br>benzene, dilute<br>caustic soda.<br>Insol. dil. acids. | o/w<br>Anionic          | Thomas Swan & Co.<br>Ltd.,<br>Consett. Co. Durham                                                     |
| CELLACOL   | Methyl cellulose.<br>General formula<br>(C <sub>6</sub> H <sub>7</sub> O <sub>2</sub> (OH)OCH <sub>3</sub> ) <sub>n</sub> | Hydrophilic body-<br>ing agent and<br>emulsion<br>stabiliser                                                                      | Stabiliser<br>non-ionic | British Celanese<br>Ltd.,<br>(obtainable from<br>J.M. Steel Ltd.,<br>Kern House,<br>Kingsway, W.C.2.) |

| Trade Name  | Composition and/or Chemical Identity | Uses                                                                                                                  | Type                 | Manufacturer                             |
|-------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------|----------------------|------------------------------------------|
| CELLOFAS A  | Methyl ethyl cellulose               | Aqueous gelling agent, emulsion stabiliser. 1% soln. visc. 5.10 cps. 20°C.                                            | Stabiliser non-ionic | I.C.I. Ltd.<br>London, S.W.1.            |
| CELLOFAS B  | Sodium carboxymethyl cellulose       | As above. 1% soln. visc. 20-80 cps. 20°C. (more prone to react with heavy metal ions and to changes in pH)            | non-ionic            |                                          |
| CITROL "A"  | Nona-ethylene glycol monooleate      | Completely sol. in xylol and white spirit. Recommended for DDT, pyrethrum, nicotine, Derris (B.P. 490,438) emulsions. | o/w Em. non-ionic    | Croda Ltd.,<br>Snailth, Goole,<br>Yorks. |
| CITROL 2 MO | Poly-glycol 200 mono-oleate          | Recommended for DDT emulsion concentrates                                                                             | o/w Em. non-ionic    |                                          |

| Trade Name     | Composition and/or Chemical Identity | Uses                                                                                                                                                                         | Type                 | Manufacturer                                           |
|----------------|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------------------------------------------------|
| CITHROL 4 MO   | Poly-glycol<br>400 mono-oleate       | Water soluble<br>ester: also<br>soluble in<br>hydrocarbons.<br>Gives a clear<br>solution when<br>added in pro-<br>portion of<br>10 parts by weight<br>to 30% DDT in<br>xylol |                      | Croda Ltd.,<br>Snaith, Goole,<br>Yorks.                |
| CITHROL 5 MO   | Poly-glycol<br>600 mono-oleate       | Can be used in<br>place of Cithrol<br>4 MO, since it is<br>more soluble in<br>water                                                                                          |                      |                                                        |
| CITHROL 4 ML   | Poly-glycol<br>400 mono-laurate      | Recommended as<br>emulsifier for DDT,<br>chlordane etc.,<br>emulsion concen-<br>trates.                                                                                      | o/w Em.<br>non-ionic |                                                        |
| CREXATOL C 100 | Alkyl aryl<br>polyethoxy<br>ethanol  | Used for DDT,<br>chlordane,<br>Rhothane, 2,4-D<br>emulsion concen-<br>trates                                                                                                 | Em.<br>non-ionic     | Rex Campbell & Co.<br>Ltd.,<br>7, Idol Lane,<br>E.C.3. |

| Trade Name    | Composition and/or Chemical Identity  | Uses                                                                                                      | Type             | Manufacturer                                         |
|---------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------|------------------|------------------------------------------------------|
| CRILL 32 *    | Poly-glycol/sorbitol oleo-laurate     | Recommended for DDT, Copper fungicides, pyrethrum, rotenone, etc. 3-10% in concentrates                   | Em.<br>non-ionic | Croda Ltd.,<br>Snaithe, Gooles, Yorks.               |
| CRILL 33      | Poly-glycol/sorbitol tall oil ester   | Recommended for DDT, etc.                                                                                 | Em.<br>non-ionic |                                                      |
| CRILL 34      | Poly-glycol/sorbitol tall oil ester   | Especially effective with xylol: DDT concentrates, alcohols, acetone, toluol. Not soluble in kerosene     | Em.<br>non-ionic |                                                      |
| CRILL 35      | Poly-glycol/sorbitol laurate          | High degree of efficiency with xylol: DDT combinations. DDT is soluble in Crill 35 to extent of 20%       | Em.<br>non-ionic |                                                      |
| EMPIAN AQ 100 | Polyethylene glycol ester. 90% active | Sol. cold water, ethyl alcohol, vegetable oils, hot hydrocarbon solvents. Partly soluble in mineral oils. | Em.<br>non-ionic | Marchon Products Ltd.,<br>Whitchaven,<br>Cumberland. |

| Trade Name                                                              | Composition and/or General Identity                           | Uses                                                                                      | Type             | Manufacturer                                                                           |
|-------------------------------------------------------------------------|---------------------------------------------------------------|-------------------------------------------------------------------------------------------|------------------|----------------------------------------------------------------------------------------|
| EMULSIFIER EFM                                                          | Tri-hydroxy methylamino methane octa-decenoate                | Emulsifier for fatty and mineral oils. Slightly sol. in water                             | Em.              | C.M. Keyworth & Co. Ltd.,<br>Barnfield Works,<br>Leek, Staffs.                         |
| EMULSIFIER LMS                                                          | Cyclohexylamine stearate                                      | Sol. in water. Suitable for w/c emulsions                                                 | Em.<br>Anionic   | Howards. Ilford Ltd.                                                                   |
| EMULSIFIER LW                                                           | Cyclohexylamine oleate                                        | Miscible with organic solvents, mineral oils. Suitable for o/w emulsions                  | Em.<br>Anionic   |                                                                                        |
| EMULSIFIER NEGO                                                         | Polyoxyethylene oleate                                        | Soluble in water, alcohol and hydrocarbon solvents. Useful for DDT, BHC, white oils, etc. | Em.<br>non-ionic | C.M. Keyworth & Co. Ltd.,<br>Barnfield Works,<br>Leed. Staffs.                         |
| ETHYLAN CP<br>(Direct U.K. equivalent of the U.S. product TRITON X 100) | Octyl phenol/ethylene oxide condensation product. 100% active | Recommended for general pesticide formulation work                                        | Em.<br>non-ionic | Lankro Chemicals Ltd.,<br>Bentcliffe Works,<br>Salters Lane,<br>Eccles,<br>Manchester. |

| Trade Name   | Composition and/or Chemical Identity                                                    | Uses                                                                                                                                                                                             | Type                 | Manufacturer                                                                |
|--------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------------------------------------------------------------------|
| ETHYLAN LD   | Coconut oil diethanolamide 100% active.                                                 | Used for blending Ethylan SE (qv.) Insol. mineral oil, kerosene. Sol. white spirit, aromatics.                                                                                                   | Stabiliser non-ionic | Lankro Chemicals Ltd., Bentscliffe Works, Salters Lane, Eccles. Manchester. |
| ETHYLAN SD   | Sperm diethanolamide                                                                    | For mineral oil emulsions only                                                                                                                                                                   | Em. non-ionic        |                                                                             |
| ETHYLAN SE   | Synergistic blend of non-ionic stabiliser and alkyl aryl polyether alcohol. 100% active | Sol. in water, aromatic solvents, white spirit; insoluble in kerosene, mineral oil, aliphatic hydrocarbon. Suitable for DDT, BHC, etc. concentrates. Also used for aldrin, dieldrin concentrates | Em. non-ionic        |                                                                             |
| Fatty Amines | Stearin                                                                                 | Oil soluble amines which are water dispersible                                                                                                                                                   | Em.                  | Guest Industrials Ltd., 84, Gracechurch St., London, E.C.3.                 |
| AMINE HPL    | dimethylamine 100%                                                                      |                                                                                                                                                                                                  |                      |                                                                             |
| AMINE OL     | Olein dimethylamine 100%                                                                |                                                                                                                                                                                                  | Em.                  |                                                                             |

| Trade Name     | Composition and/or Chemical Identity                 | Uses                                                                                                                      | Type            | Manufacturer                                                      |
|----------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------|
| Fatty nitriles |                                                      |                                                                                                                           |                 |                                                                   |
| NK             | General formula<br>R C N                             | Soluble in organic solvents. Insoluble in water. Recommended for preparation of DDT emulsions, herbicidal emulsions, etc. | Em.             | Guest Industrials Ltd.,<br>81, Gracechurch St.,<br>London, E.C.3. |
| IZ             | R hydrocarbon chain occurring in natural fatty acids |                                                                                                                           | Em.             |                                                                   |
| GEMEX Z-9      | Aliphatic nitrogen compound                          | Soluble in water. Suggested for the preparation of DDT emulsion concentrates                                              | Em.<br>Cationic | Genec Ltd.,<br>120. Moorgate,<br>London, E.C.2.                   |
| LANKROPOL WNA  | Sulphated mono-esters of fatty acids                 | Specially prepared for kerosene emulsions (o/w emulsions formed with 5 to 10% based on weight of kerosene)                | Em.             | Lankro Chemicals Ltd.                                             |

| Trade Name   | Composition and/or Chemical Identity                    | Uses                                                                                                                                                         | Type             | Manufacturer                                                                               |
|--------------|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------------------|
| LISSAPOL NX  | Alkylated phenol/ethylene oxide condensate. (Anhydrous) | Soluble in lower alcohols, acetone, pine oil, benzene, toluene, xylene. Benzol, xylol, oleic acid, chlorinated solvents soluble up to 10% Kerosene insoluble | Em.<br>non-ionic | I.C.I. Ltd.,<br>London, S.W.1.                                                             |
| LISSAPOL NXA | As above, but containing a low water content            | This grade is used as a wetter for water-sensitive insecticides of the organic phosphate type                                                                | Em.<br>non-ionic |                                                                                            |
| LUBROL MOA   | Long chain fatty alcohol/ethylene oxide condensate      | This emulsifier can be used with Lissapol NX to effect its solubilisation in solvents such as kerosene                                                       | non-ionic        |                                                                                            |
| M.B. 320     | Cyclohexylamine lauryl sulphate                         | Extensively used in concentrates of DDT, IUC, hormone type herbicides, etc. Soluble in benzol, xylol, kerosene, etc.                                         | Em.              | Ronsheim & Moore Ltd.,<br>Grosvenor Gardens House,<br>Grosvenor Gardens,<br>London, S.W.1. |

| Trade Name    | Composition and/or Chemical Identity | Uses                                                                                      | Type             | Manufacturer                                                |
|---------------|--------------------------------------|-------------------------------------------------------------------------------------------|------------------|-------------------------------------------------------------|
| MORPAN OH     | Hexadecyl trimethyl ammonium bromide | Mainly used as an emulsion stabiliser, antioxidant, and a flocculent for powder particles | Stabiliser       | Glovers Ltd.,<br>Wortley Low Mills,<br>Leeds 12.            |
| NERVAN EL     | Alkyl/aryl sulphonate 40% active     | Suggested as a general purpose emulsifier                                                 | Em.              | Normal Evans & Rais Ltd.,<br>Dudley Road,<br>Manchester 16. |
| NONAID SB 100 | Fatty alkylolamide                   | Soluble in water, polar and semi-polar solvents                                           | Em.<br>non-ionic |                                                             |
| NONEX 25      | Polyethylene glycol 200 monoleate    | Recommended as general purpose emulsifiers                                                | Em.<br>non-ionic | Gamec Ltd.,<br>120, Moorgate,<br>London, E.C.2.             |
| NONEX 26      | Polyethylene glycol 300 monoleate    |                                                                                           |                  |                                                             |
| NONEX 30      | Polyethylene glycol 400 monoleate    |                                                                                           |                  |                                                             |
| NONEX 52      | Polyethylene glycol 600 monoleate    |                                                                                           |                  |                                                             |

| Trade Name        | Composition and/or Chemical Identity                                                                        | Uses                                                                                   | Type           | Manufacturer                                             |
|-------------------|-------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|----------------|----------------------------------------------------------|
| OP Condensate 45  | Condensation product obtained from 1 unit of octyl phenol and 9 units ethylene oxide                        | Development product suggested as a general surface-active agent                        | non-ionic      | Petrochemicals Ltd.,<br>170, Piccadilly,<br>London, W.1. |
| OC Condensate 50  | Similar to above but obtained from 1 unit of octyl cresol and 9 units ethylene oxide                        | As above                                                                               | non-ionic      |                                                          |
| OCA Condensate 70 | As above but obtained from 1 unit oleyl cetyl alcohol and 14 units of ethylene oxide                        | As above                                                                               | non-ionic      |                                                          |
| PENTRONE          | Higher fatty alcohol sulphates                                                                              | Suggested as a general purpose emulsifier, Claimed to have good penetrating properties | Em.            | Glovers Ltd.,<br>Wortley Low Mills,<br>Leeds 12.         |
| PERMINAL EML      | Aqueous solution of sodium alkyl naphthalene sulphate with a liquified colloid and other stabilising agents | Recommended for the preparation of two-phase mayonnaise type o/w emulsions             | Em.<br>Anionic |                                                          |

| Trade Name                                    | Composition and/or Chemical Identity                                                                                                                                                                                                                                   | Uses                                                                                                                 | Type             | Manufacturer                                                                      |
|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|------------------|-----------------------------------------------------------------------------------|
| PETROMOR PALE A<br>PETROMOR 276<br>PETROMOR N | Blends of mineral oil and oil soluble sulphonates                                                                                                                                                                                                                      | Miscible in all properties with oil, organic solvents. General emulsifiers, claimed to produce fine stable emulsions | Em.<br>Anionic   | Manchester Oil Refinery Ltd.,<br>Twining Road,<br>Trafford Park,<br>Manchester 17 |
| Polyethylene glycol esters                    | Polyethylene glycol mono-laurate 200<br>Polyethylene glycol mono-stearate 400<br>Polyethylene glycol mono-oleate 600<br><br>The number above refers to the average molecular weight of the parent glycol and depends on the chain length of the ethylene oxide residue | General purpose emulsifiers                                                                                          | Em.<br>non-ionic | A. Boake Roberts & Co. Ltd.,<br>Carpenters Row,<br>Stratford,<br>London, E.15     |

| Trade Name | Composition and/or Chemical Identity                                                                                          | Uses                                                                                                                                        | Type          | Manufacturer                                                      |
|------------|-------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------------------------------------------------|
| PEG Esters | Polyethylene glycol esters                                                                                                    | General purpose emulsifiers                                                                                                                 | Em. non-ionic | Norman Evans & Rals Ltd.,<br>Dudley Road,<br>Manchester 16        |
| PEG 400    | PEG mono-oleate<br>PEG mono-laurate<br>PEG mono-stearate<br>Diglycol mono-stearate                                            |                                                                                                                                             |               |                                                                   |
| QUERTONS   |                                                                                                                               |                                                                                                                                             |               |                                                                   |
| 2 KKES     | Not known                                                                                                                     | Quarternary emulsifiers                                                                                                                     | Em Cationics  | Guest Industrials Ltd.,<br>81, Gracechurch St.,<br>London, E.C.3. |
| HPLES      |                                                                                                                               |                                                                                                                                             |               |                                                                   |
| OLFS       |                                                                                                                               |                                                                                                                                             |               |                                                                   |
| RANOTEX CW | Octadecyl/hexadecyl carboxymethyl trimethyl ammonium chloride<br>$C_{18}H_{37}/C_{16}H_{33}OOCCH_2N(CH_3)_3$ C1<br>95% active | Sol. in water, esters, acetone. For preparation of positively charged emulsions especially in combination with non-ionic emulsifying agents | Em. Cationic  | Glovers Ltd.,<br>Wortley Low Mills,<br>Leeds 12.                  |

| Trade Name                       | Composition and/or Chemical Identity                                                                                                                    | Uses                                                                                            | Type             | Manufacturer                                                                            |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------------------|-----------------------------------------------------------------------------------------|
| SPANS *<br>or<br>ARLACELS        | 20<br>Sorbitan mono-laurate<br>40<br>Sorbitan mono-palmitate<br>60<br>Sorbitan mono-stearate<br>80<br>Sorbitan mono-oleate<br>85<br>Sorbitan tri-oleate | General purpose emulsifiers                                                                     | non-ionic        | Honeywill-Atlas Ltd.,<br>Devonshire House,<br>Mayfair Place,<br>Piccadilly, W.1.        |
| Sulphonated "Lorol"<br>Liquid CY | Cyclohexylamine lauryl sulphate.<br>50% solution in water                                                                                               | Recommended as an emulsifier.<br>Miscible to certain extent with turpentine, white spirit, etc. | Em.              | Ronsheim & Moore Ltd.,<br>Grosvenor Gardens House,<br>Grosvenor Gardens, London, S.W.1. |
| TERGITOL TMN<br>TD               | Polyethylene glycol alkyl ethers.<br>100% active                                                                                                        | As general purpose emulsifiers                                                                  | Em.<br>non-ionic | Gemec Ltd.,<br>120, Moorgate,<br>London, E.C.2.                                         |

| Trade Name  | Composition and/or Chemical Identity                    | Uses                                               | Type             | Manufacturers                                                                    |
|-------------|---------------------------------------------------------|----------------------------------------------------|------------------|----------------------------------------------------------------------------------|
| TEXOFORS    | Ethylene oxide type products with fatty groups attached | General purpose emulsifiers                        | Em.<br>non-ionic | Glovers Ltd.,<br>Wortley Low Mills,<br>Leeds 12.                                 |
| TEXOGENT FA | Higher fatty alcohol sulphate                           | General purpose emulsifier.<br>Miscible with water | Em.              |                                                                                  |
| TWEENS* 20  | Polyoxyethylene sorbitan mono-laurate                   |                                                    |                  | Honeywill-Atlas Ltd.,<br>Devonshire House,<br>Mayfair Place,<br>Piccadilly, W.1. |
| 21          | Polyoxyethylene sorbitan mono-laurate                   |                                                    |                  |                                                                                  |
| 40          | Polyoxyethylene sorbitan mono-palmitate                 | General purpose emulsifiers                        | non-ionic        |                                                                                  |
| 60          | Polyoxyethylene sorbitan mono-stearate                  |                                                    |                  |                                                                                  |
| 61          |                                                         |                                                    |                  |                                                                                  |

| Trade Name | Composition and/or Chemical Identity            | Uses                        | Type      | Manufacturer                                                                     |
|------------|-------------------------------------------------|-----------------------------|-----------|----------------------------------------------------------------------------------|
| TWEENS *   | <div> 80 </div> <div> 81 </div> <div> 85 </div> | General purpose emulsifiers | non-ionic | Honeywill-Atlas Ltd.,<br>Devonshire House,<br>Mayfair Place,<br>Piccadilly, W.1. |

\* Certain members of the "Arlacels", "Spans" and "Tweens" are equivalents of the "Crills".

For details of this relationship see P.A.N.S. Section A, No. 30, p.51, Dec. 1954.

#### Abbreviations

Em. = Emulsifier; Insol. = Insoluble; o/w = Oil in water;  
Sol. = Soluble; w/o = Water in oil.

A LIST OF SURFACE-ACTIVE AGENTS MANUFACTURED IN THE UNITED KINGDOM (1955)

B. WETTING AND SPREADING AGENTS

| Trade Name       | Composition and/or Chemical Identity                                                       | Uses                                                                                         | Type    | Manufacturer                                                                                  |
|------------------|--------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|---------|-----------------------------------------------------------------------------------------------|
| AEROSOL OT       | See MANOXOL OT                                                                             |                                                                                              |         |                                                                                               |
| ALCOPOL O        | Sodium dioctyl sulphosuccinate. 100% active                                                | Recommended as an aid to wetting and penetration of insecticidal and fungicidal preparations |         | Allied Colloids (Manufacturing) Co. Ltd.,<br>11, Gt. St. Thomas Apostle,<br>Queen St., E.C.4. |
| APHROSOL FC      | Aqueous solution of sodium alkyl-naphthalene sulphonate, modified glue and foam stabiliser | Recommended as a wetting agent with "sticker" properties                                     | Anionic | I.C.I. Ltd.,<br>London, S.W.1.                                                                |
| ARYLAN IPA       | Amine neutralised alkyl aryl sulphonate. 30% active                                        | Suggested as a wetting agent, especially for amine neutralised 2,4-D acids                   | Anionic | Lankro Chemicals Ltd.,<br>Bentcliffe Works,<br>Salters Lane,<br>Eccles, Manchester.           |
| CALSOLENE OIL HS | Aqueous solution of the sodium salt of a highly sulphated oil                              | General wetting and spreading agent                                                          | Anionic | I.C.I. Ltd.,<br>London, S.W.1.                                                                |

| Trade Name  | Composition and/or Chemical Identity                                   | Uses                                                                                                                                    | Type      | Manufacturer                                             |
|-------------|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------------------------------------------------|
| CASA 53     | Mixture surface active primary and secondary amines. 100% active       | General wetting agent                                                                                                                   | Cationic  | T. Swan & Co.,<br>Consett, Co. Durham.                   |
| CASA 146 K  | Cetyl pyridinium bromide                                               | Quarternary compound, for wetting purposes                                                                                              | Cationic  |                                                          |
| CRILL 31    | Glycerol/mannitan mono-laurate                                         | Wetting agent for derris, pyrethrum, sulphur, copper, lead, arsenic, Bordeaux mixture, etc. Also claimed to have synergistic properties |           | Croda Ltd.,<br>Snaith, Goole,<br>Yorks.                  |
| DISPERSOL T | Condensation product of formaldehyde and sodium naphthalene sulphonate | Primarily a dispersing agent, and as a grinding assistant, also a fundamental ingredient of dispersible powders                         | Anionic   | I.C.I. Ltd.,<br>London, S.W.1.                           |
| L 53        | Polyoxyethylene fatty acid ester                                       | Good wetter, sol. in water, not affected by dilute acids. Dissolves DDT, TEPP, chlordane, and many herbicides                           | Non-ionic | C.M. Keyworth Ltd.,<br>Barnfield Works,<br>Leek, Staffs. |

| Trade Name        | Composition and/or Chemical Identity                   | Uses                                                                              | Type      | Manufacturer                                                                      |
|-------------------|--------------------------------------------------------|-----------------------------------------------------------------------------------|-----------|-----------------------------------------------------------------------------------|
| LENSEX            | Sodium higher alkyl sulphate, see TEEPOL. 44% active   | Paste form of Teepol, and similar to Teepex                                       | Anionic   | Shell Chemicals Ltd.                                                              |
| LIMSOPON 678/40   | Sulphated lauryl alcohol                               | Recommended for wetting purposes                                                  |           | F.W. Berk & Co. Ltd.,<br>P.O. Box 193,<br>1-19, New Oxford St.,<br>London, W.C.1. |
| MANOXOL OT        | Diocetyl sodium sulphosuccinate. 100% active           | General wetting agents                                                            | Anionic   | Hardman & Holden Ltd.,<br>Manox House,<br>Miles Platting,<br>Manchester, 10.      |
| MANOXOL N         | Sodium dinonyl sulphosuccinate                         |                                                                                   |           |                                                                                   |
| METANOL DB POWDER | Alkyl aryl sulphononic acid type. 40% active           | Stable in hard waters, suitable in dispersible powders as spreader and dispersant | Non-ionic | Bernard Keegan Ltd.,<br>Bradford, Yorks.                                          |
| NANSA S POWDER    | Based on dodecyl benzene sodium sulphonate. 40% active | Recommended as a wetting agent in DDT sprays                                      |           | Marchon Products Ltd.,<br>Whitehaven,<br>Cumberland.                              |

| Trade Name      | Composition and/or Chemical Identity                | Uses                                                                              | Type    | Manufacturer                                                                        |
|-----------------|-----------------------------------------------------|-----------------------------------------------------------------------------------|---------|-------------------------------------------------------------------------------------|
| NERVAN CFB      | Sodium alkyl naphthalene sulphonate. 40% active     | Recommended as a wetting agent for dispersible powders (0.1% on weight of powder) | Anionic | Norman Evans & Rais Ltd.,<br>Dudley Road,<br>Manchester, 16.                        |
| NONEX 139       | Polyethylene glycol 400 mono-laurate                | Wetting agents for use with chlorinated insecticides, weedkillers, etc.           |         | Gemec Ltd.,<br>120, Moorgate,<br>London, E.C.2.                                     |
| NONEX 501       | Methoxy polyethylene glycol laurate                 |                                                                                   |         |                                                                                     |
| PERMIAL BX      | Sodium salt of alkylated naphthalene sulphonic acid | Soluble in water: mainly used as a wetting agent                                  | Anionic | I.C.I. Ltd.,<br>London, S.W.1.                                                      |
| PENTRONE T      | Fatty alcohol sulphate                              | As a general wetting agent                                                        |         | Glovers Ltd.,<br>Wortley Low Mills,<br>Leeds, 12.                                   |
| PETROSOL POWDER | Water soluble petroleum sulphonates 33% active      | As general wetting and spreading agents of low solubility in oils                 | Anionic | Manchester Oil Refinery Ltd.,<br>Twining Road,<br>Trafford Park,<br>Manchester, 17. |
| PETROSOL 33     |                                                     |                                                                                   |         |                                                                                     |
| PETROSOL 55     |                                                     |                                                                                   |         |                                                                                     |

| Trade Name                                                                          | Composition and/or Chemical Identity                                                                                                               | Uses                                                                       | Type    | Manufacturer                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sulphite lye also known as Sulphite cellulose lignin; lignin pitch; bindex; goulac  | Lignosulphonates of sodium or calcium, obtained by evaporation of the concentrate liquor obtained in wood pulp manufacture by the sulphite process | Used as general purpose wetting agent, spreader, and auxiliary emulsifier  | Anionic | Obtainable from:-<br>Lambeth & Co.<br>(Liverpool) Ltd.,<br>Greenock St.,<br>Liverpool, 3.<br>Production Chemicals,<br>(Rochdale) Ltd.,<br>32, Deansgate,<br>Manchester, 3.<br>Wood Chemicals Ltd.,<br>Commonwealth House,<br>1-19, New Oxford St.,<br>W.C.1. |
| Sulphonated Castor Oil<br>also known as<br>Turkey Red Oil,<br>Red Olein,<br>Red Oil | Composition varies, but usually contains sodium, potassium and ammonium salts of sulphonated ricinoleic acid and glyceride                         | Well established use as a wetting agent, spreader and auxiliary emulsifier | Anionic | A. Boake Roberts Ltd.,<br>Carpenters Road,<br>Stradford,<br>London, E.15.                                                                                                                                                                                    |

| Trade Name                 | Composition and/or Chemical Identity                                                                    | Uses                                         | Type    | Manufacturer                                                                 |
|----------------------------|---------------------------------------------------------------------------------------------------------|----------------------------------------------|---------|------------------------------------------------------------------------------|
| Sulphonated Lorols Paste   | Derivatives of sulphated lauryl alcohol. 30% fatty alcohol (40-45% sodium alkyl sulphate) and 50% water |                                              |         | Ronsheim & Moore, Grosvenor Gardens House, Grosvenor Gardens, London, S.W.1. |
| Powder                     | Dehydrated form of the paste. Contains 50% sodium sulphate                                              | General purpose wetting and spreading agents | Anionic |                                                                              |
| Double Concentrated Powder | Dehydrated form of the paste, without sodium sulphate                                                   |                                              |         |                                                                              |
| Liquid NH                  | Ammonium derivative. 30-40% ammonium lauryl sulphate in water                                           |                                              |         |                                                                              |
| Liquid TA                  | Triethanolamine lauryl sulphate 30-40% in water                                                         |                                              |         |                                                                              |
| SHELLESTOL                 | See TERPOL                                                                                              |                                              |         |                                                                              |

| Trade Name           | Composition and/or Chemical Identity                                                                                                        | Uses                                                                                          | Type    | Manufacturer                                                         |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------|----------------------------------------------------------------------|
| TEEPOL<br>SHELLESTOL | Sodium higher alkyl sulphate, general formula<br>$\begin{array}{c} R \\ \diagup \\ CH_2O.SO_3Na \\ \diagdown \\ R_1 \end{array}$ 21% active | General purpose wetting agent, stable over a wide pH range. Recommended at 0.1% concentration | Anionic | Shell Chemicals Ltd.,<br>Norman House,<br>105-109, Strand,<br>W.C.2. |
| TEPEX                | As above. 42% active                                                                                                                        | As Teepol, but in paste form                                                                  | Anionic |                                                                      |
| TERGITOL 7           | Aqueous solution, sodium heptadecyl sulphate 25%                                                                                            | General purpose wetting agent: used where electrolyte is below 1%                             | Anionic | Gemec Chemicals Co.,<br>120, Moorgate,<br>London, E.C.2.             |
| TERGITOL P.28        | Aqueous solution, sodium dioctyl phosphate, 25%                                                                                             | General purpose wetting agent. Insoluble in acid, stable in alkali                            | Anionic |                                                                      |

| Trade Name       | Composition and/or Chemical Identity                                                                                                                                                                                                                                                   | Uses                                                                                       | Type    | Manufacturer                          |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------|---------------------------------------|
| ZYLAPOL DL       | Long branch chain alcohol sulphate, C <sub>12</sub> -C <sub>16</sub> , 35% active                                                                                                                                                                                                      | As wetting, spreading and penetrating agent                                                | Anionic | Bernard Keegan Ltd., Bradford, Yorks. |
| ZYLASIL EX PASTE | Di alkyl aryl sulphononic acid type<br><div style="text-align: center;"> <math>\begin{array}{c} R_1 \\ \diagup \quad \diagdown \\ \text{Cyclohexane ring} \\ \diagdown \quad \diagup \\ R_2 \end{array}</math> </div> R <sub>1</sub> , R <sub>2</sub> short chain alcohols. 40% active | As spreading, wetting and penetrating agent. Recommended especially for use with DNC, etc. | Anionic |                                       |
| ZYLASIL W.E.T.   | Di alkyl ether, sulphonate<br>$\begin{array}{c} R_1-O \\ \quad \diagup \\ \quad CH-CH_2(CH_2-CH_2O) \\ \quad \diagdown \\ R_2-O \end{array} CH_2-O-SO_2Na$ 60% active                                                                                                                  | Used a very low concentrations as a wetting and spreading agent                            | Anionic |                                       |

SUPPLEMENT II

COMPATIBILITIES TABLE

|               | Aldrin | BHC | Chlordane | DDT | DNC | Dieldrin | EPN | Heptachlor | Lead Arsenate | Malathion | Methoxychlor | Nicotine | Parathion | Pyrethrins | Systox | TDE | TEPP | Toxaphene |
|---------------|--------|-----|-----------|-----|-----|----------|-----|------------|---------------|-----------|--------------|----------|-----------|------------|--------|-----|------|-----------|
| Aldrin        |        | C   | C         | C   | C   | C        |     | C          | C             | C         | C            | C        | C         | C          | C      |     | O    | C         |
| BHC           | C      |     | C         | C   | X   | C        | C   | C          | C             |           | C            | O        | C         | C          | C      | C   | C    | C         |
| Chlordane     | C      | C   |           | C   | C   | C        | C   | C          | C             | C         | C            | O        | C         | C          | C      | C   | I    | C         |
| DDT           | C      | C   | C         |     | C   | C        | C   | C          | C             |           | C            | O        | C         |            | C      | C   | C    | C         |
| DNC           | C      | X   | C         | C   |     | C        | X   | C          | X             |           |              | X        | X         | O          | X      | X   | X    | C         |
| Dieldrin      | C      | C   | C         | C   | C   |          |     |            |               |           |              | C        | C         |            | C      | C   | O    | C         |
| EPN           |        | C   | C         | C   | X   |          |     | C          |               |           | O            | C        |           |            | C      | C   |      |           |
| Heptachlor    |        | C   | C         | C   | C   |          |     |            |               |           |              |          | C         |            |        |     | C    | C         |
| Lead Arsenate | C      | C   | C         | C   | X   | C        |     |            | C             |           | C            | C        | C         | C          | C      | C   | C    | C         |
| Malathion     |        |     | C         | C   |     |          |     | C          |               | C         | C            |          |           |            | C      |     |      |           |
| Methoxychlor  | C      | C   | C         |     |     |          |     |            |               | C         |              | C        | C         |            |        |     | C    |           |
| Nicotine      | C      | O   | O         | O   | X   | C        | O   |            | C             |           | C            |          | O         | C          | C      | C   | O    | C         |
| Parathion     | C      | C   | C         | C   | X   | C        | C   | C          | C             | C         | C            | O        |           | C          |        | C   | C    | C         |
| Pyrethrins    | C      | C   | C         |     | O   |          |     | C          |               |           | C            | C        |           | C          |        | C   | O    | C         |
| Systox        | C      | C   | C         | C   | X   | C        |     |            | C             |           | C            |          | C         |            |        |     |      | C         |
| TDE           |        | C   | C         | C   | X   | C        | C   |            | C             | C         |              | C        | C         |            |        |     | C    | C         |
| TEPP          | O      | C   | I         | C   | X   | O        | C   | C          | C             |           | C            | O        | C         | O          |        |     | C    | C         |
| Toxaphene     | C      | C   | C         | C   | C   | C        |     | C          | C             |           |              | C        | C         | C          | C      | C   |      | C         |

KEY

C = Compatible

I = Incompatible

X = Should not be used together owing to increased toxicity to the operator.

O = Physically compatible, and combination does not increase phytotoxicity. Residual effectiveness of either or both is reduced when in admixture.

